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ANIMAL MORPHOLOGY IN ITS RELATION TO OTHER SCIENCES.

IN the system of classification adopted by the organizers of this congress the science of animal morphology is apparently to be defined so as to exclude comparative anatomy. I take it, consequently, that it is intended to include only the broader problems connected with the form of animals—such as the phylogenetic evolution of form, the embryological development of form and the restoration of the mutilated form—in general, the form-producing and form-maintaining factors.

Expressed in this way the relations of animal morphology become more evident; and clearly the first and most intimate of these relations is with the morphology of plants. The separation of animal morphology from plant morphology in the department of biology, while according with a division of the subject found to-day in our universities, is, I think, not an ideal condition. For the form-producing and the form-maintaining factors are, at bottom, the same in all organisms. The problem of what factors have worked to determine whether a fish or a man shall have such and such a form is identical with that of the determination of the form of a fern or an oak. Little by little the morphologists that deal with the broader aspects of their science are being forced to face the absurdity of its division on the basis of the material studied. In cytology it is found that the maturation of the germ-cells, the fertilization of the egg and cell-divisions, are identical processes in the two 'king-

doms.' To admit a plant cytology and an animal cytology is only less absurd than to admit a mammalian cytology, an avian cytology and a reptilian cytology.

What is true of cytology is true of the other branches of morphology such as embryology in its broadest sense, the phenomena of regeneration and regulation in organisms, and especially the evolutionary history of specific forms. While in taxonomy we must continue to have botanists and zoologists, as we shall continue to have ornithologists, entomologists, etc., yet outside of the purely descriptive subsciences I would the gulf between botanists and zoologists were annihilated and that we had biologists separated rather in regard to *subjects* and university chairs, journals and societies devoted to evolution, cytology, ontogenetic processes and form regulation without regard to the systematic position of the material studied. Then we might hope to advance a subject instead of mulling over endless descriptive details.

We have next to consider the relations of morphology to form evolution or phylogeny. Before we can consider how a new form arises we must clear the field by seeking some element of form. The mass of material in the organic, like that in the inorganic, world early led to an attempt at the classification of these materials in both biology and chemistry. In chemistry a certain number of kinds of materials have in course of time been catalogued and are called substances, each of which has its particular *molecular* composition. In biology likewise many thousand kinds of organisms have been catalogued, and these are called species, each made up of particular sorts of *individuals*. Chemistry has gone a step further in its analysis of inorganic matter and recognized that the different molecules are made up of diverse combinations of a relatively small number of units called atoms. To-day biology has to recognize that its individuals are likewise diverse combinations of units—relatively very numerous—which, following de Vries, we call unit characters, or we may use the simpler name of 'characteristics.' Characteristics are thus to individuals what atoms are to molecules. As the qualities and behavior of molecules are determined by their constituent atoms, so the essence of the individuals of any species is determined by its constituent characteristics. And as we may construct new substances at will by making new combinations of atoms, so we may produce new species at will by making new combinations of characteristics. The making of new combinations in molecules or species is a useful work, but it is not evolution. Evolution in the inorganic or the organic world is first achieved when we can make new atoms or new characteristics, as the case may be.

This conception of species, which has arisen during the present decade, has its germ in the work of Mendel, and in consequence of the stimulating researches of de Vries, Correns, Tschermak, Bateson and others has developed into a stately doctrine, a doctrine which bids fair to revolutionize biology as the atomic theory did chemistry. It adds at once a new dignity and interest to morphology as well as to the description of species or taxonomy. In describing the form of an animal we are enumerating its qualities. Many of these are directly the unit characters of the species; others are composite and may be analyzed, by appropriate methods of breeding, into the elemental characteristics.

I may illustrate this by reference to domesticated poultry, to which I am now paying some attention. It is impossible to enumerate all of the characteristics of poultry, but the following are some of the most striking:

Size: Large and dwarf, which are ex-

emplified in the Asiatic breeds and the bantams.

Colors: Black; buff or red; white; brown (in the female) the male being often bronze, green, black, yellow and white; barred (as in the Plymouth Rock) and spangled (having center of feather of different color from periphery).

Comb: Single, pea, rose (flat, covered with tubercles, like a file); replaced by crest.

Legs: Feathered, featherless; black, blue, yellow, horn color.

Body shape: Short and chunky; tall and slender.

Now the various varieties of fowl are made up of various combinations of these characters. Thus we may have Plymouth Rocks which instead of having bars are pure white, or all buff; or the single comb may be replaced by a rose comb (when they are called Wyandottes), the usually clear legs may be feathered, and, finally, they may be 'bantamized.'

Any desired characteristic in the whole catalogue of poultry characteristics might be engrafted upon an original Plymouth Rock stock. We might put on it the crest of the Polish fowl or the twisted feathers of the frizzle, or the loose barbs of the silky, or the taillessness of the rumpless or the long tail feathers of the Japanese long-tailed fowl. All this is of course possible because of the cross fertility of the races having these different characteristics. By similar procedure we might make a white, blue-eyed, deaf, long-haired, tailless, seven-toed cat; engraft the horns of the Dorset sheep upon the hornless Southdown; add the fecundity of the two-nippled horned Dorset to the multinippled condition of Dr. Alexander Graham Bell's flock. We might expect, after some experience, to do this with the same certainty that we can get calcium chloride and carbonic acid out of a mixture of hydrochloric acid and marble.

The bearing of this illustration, I repeat, is to show us that characteristics of species are entities not a little of whose interest lies in the question of their origin in each case. When we know how such characteristics arise, then we may call them forth at will and so determine the evolution of organic form. For the present it is sufficient that by the acquisition of new characteristics new species have arisen from preceding ones.

This assertion is justified by the examination of any extensive synopsis of species. Take, for example, de Bormans's synopsis of Forficulidæ in 'Das Tierreich.' Take any synoptic key at random. *Apterygida japonica* has two large tubercles at the end of the abdomen. *Apterygida allipes* has four small ones. *Anisolabis xenia* differs from *A. littorea* by slightly smaller size and especially by having two teeth in the forceps in the male or three in the female instead of none at all. I do not mean to assert that species have arisen *only* by an addition or subtraction of characteristics, but this is a common method. Very often we find one characteristic being replaced by another. Thus in Lepidoptera one species may differ from another in the replacement of red by yellow; or one earthworm will differ from another by having the sexual openings in different segments. We have no reason for thinking that these characteristics are not integral entities as much as those distinguishing domestic races. The modern morphologist, therefore, with the significance of characteristics in mind must appreciate that in enumerating these characteristics he is enumerating the steps of evolution.

The relations of morphology to embryology are so intimate that the latter is commonly reckoned a subdivision of the former. Certainly the interpretation of the

adult form depends on a knowledge of its development. 'In terms of the ancient riddle,' says Bateson (*Nature*, Vol. 70, p. 412) in his recent address as president of the section of zoology in the British Association, 'In terms of the ancient riddle we must reply that the owl's egg existed before the owl, and if we hesitate about the owl we may be sure about the bantam.' The characteristics of the adult form are implicit in the fertilized egg and are determined by the Anlagen of the characteristics wrapped up in that egg. We know now that upon the symmetry of the egg and of the successive cleavages often, if not typically, the symmetry of the adult form depends, and that upon the lack of symmetry of cleavage in Gastropods their lack of symmetry is probably to be referred. In the successive cleavages definite organ-tracts are marked off and still later the epidermal organs, such as hair, feathers and scales—the bearers of the more evident heredity characteristics—are laid down in regular lines radiating often from single points or groups of cells, thus simplifying the problem of inheritance of peculiarities of plumage or coat color by referring them back to transmission through particular cells or cell groups. It has thus been possible to show that all the numerous dorsal appendages of the nudibranch mollusc *Eolis* are derived from material split off in a regular manner and at regular intervals from a group of cells lying in the tail end of the developing animal. Thus the interpretation of the mechanism of transmission of qualities is first gained from a study of embryology.

A second way in which embryology has been regarded as indispensable to morphology is in the light it has thrown on homology. By homology—the will-o'-the-wisp of morphology—is meant such a similarity of unlike things in different species as would justify their receiving the same name. And one of the strongest grounds of a homology is similarity of origin regardless of function or even ultimate anatomical connections. The search for homologies has led to the idealization of the 'type,' and this more than anything else has blinded morphologists to the facts of variation and evolution. When, however, twenty-two vertebræ in place of twenty-one can nonplus the seeker after homology, its ethereal nature is sufficiently indicated. Homology may, indeed, exist between normal types, but the abnormal or pathological is often beyond homology and yet just the abnormal is, paradoxical as it may sound, the important for evolution.

As we study an organism's form we see that it is not made up merely of a great number of characteristics, but that these characteristics are, on the whole, such as enable the animal to thrive in its environment. We are struck by their 'adaptive' nature.

I am well aware that twenty years or so ago this side of morphology—the side, namely, of the accounting of an organism's form on the ground of use—was little cultivated. Morphology had for its aim the discovery of the interrelation of parts in the individual organism and the homology of parts in different individuals or species, and if it sought to go further it indulged only in speculative inferences as to the probable function of the parts. On the whole the student's attention was directed towards connections of organs and his natural inquiry as to use was stifled. Some one said that function varies while the form persists. This phrase became a dogma and function was considered a matter too trivial for consideration. Homology was the study for men of science; analogy was for the dilettanti. Morphologists should have been warned by cases like the whale whose teeth can not be homologized

with those of other mammals, and not have underrated the limitations of homology nor the importance of the study of adaptations. Only within the last few years have we come to recognize that every organ is more than a homologue: it is also a successful experiment with the environment.

The existence of that relation between form and environment which we call adaptation has been recognized for centuries, yet its full significance is still obscure. The prevailing theory (of Darwin) assumes that a change in environment precedes any change in form and that adaptation is, therefore, necessarily achieved by a change in the mean of the form to meet the changed demands of the new environment. This theory may, indeed, be said to be the natural outcome of the morphological doctrine of fundamental fixity of type. The type could be bent to meet new conditions, but could receive nothing new nor suffer loss of parts. I find that in the pre-Darwinian epoch Prichard suggested that the creator made the various species and placed them in habitats for which their structure fitted them. We see in this suggestion translated into modern terms the germ of a very different theory of adaptation from the prevailing one. I expressed this nearly two years ago about as follows: "The world contains numberless kinds of habitats or environmental complexes capable of supporting organisms. The number of kinds of organisms is very great; each lives in a habitat consonant with its structure." Each species is being widely dispersed while, at the same time, it is varying or mutating. By chance, some variants of the species get into an environment worse fitted for them; others into one better fitted. "Those that get into the worse environment can not compete with the species already present; those that get into a habitat that completely accords with their organization will probably thrive and may make room for themselves, even as the English sparrow has made room for itself in this country. This process may go on until the species is found only in the environment or environments suited to its organization. As Darwinism is called the survival of the fittest organisms, so this may be called the theory of segregation in the fittest environment."

The principle that animals are found in habitats for which their structure fits them, and not elsewhere, points to the close relation existing between morphology and geography. We find the animals of the seashore, such as sponges, Hydro- and Anthozoa, and tunicates, to be largely sessile, and in consequence, of the radiate type of structure. This sessile habit makes it possible for them to maintain their hold on the rocks from which the beating waves tend to tear them. Those which are not actually permanently attached have means enabling them to cling closely to the rocks; such are the echinoderms, the molluscs, many annelids and crustaceans. The animals of the surface of the sea, such as siphonophores, ctenophores, jelly fishes and larvæ, are without such clinging organs; they include species whose organization permits them only to float or swim at or near the surface. The deep sea could have been populated more readily, so far as proximity goes, from the surface organisms than from those of the shore line; but only the latter offered the structural features consonant with life at the sea bottom and so the deep sea became populated thence. In the swift-flowing rivers we find powerful swimmers or animals that can hold fast to the bed of the stream and in ponds we find those species which have some means of preserving their continuity in time of drought. In caves we get not any forms which happen to be washed into them, but only darkness, moisture- and contact-lovers. In deserts whole groups of

animals are absent, only those occurring with thickest skin—least apt to lose water by transpiration—such as certain snakes, lizards and hard-shelled beetles. In general, in studying the geographical distribution of animals in environments presenting extreme conditions we find that they clearly have been selected from groups presenting the most favorable characteristics. All of this indicates that, often at least, the already existing morphological conditions have determined the fitness of a species to cope with the environment—morphological characteristics have determined geographical and climatic distributions.

Morphology as the science of form is often contrasted with physiology, the science of function. Yet between the two is the closest possible relation, because an organ implies a function and every morphological characteristic has a corresponding physiological characteristic. As physiological characteristics are transmissible in the same way as morphological, we may think of any individual as being made up of such functional characteristics, just as a molecule is made up of atoms, and in the transfer from one race or species of a set of morphological characteristics we transfer likewise the corresponding set of physiological characteristics. Thus to return to poultry, we find the rate of growth, the age at maturity, the egg production, the brooding instinct and the resistance to disease to be characteristics of various races, and it is quite possible to combine such characteristics—in so far as they are not incompatible—in various ways. Thus we have poultry that mature early, lay many eggs and are not broody—of these the white Leghorn is a good example. Or, we may have poultry that grow large, mature late, lay throughout the winter and are very broody—such are the Cochins. This similarity in capacity for making combinations which we see between physiological and morphological characteristics proves their close kinship and the unscientific nature of the division which would relegate their study to distinct sciences.

What is true of domesticated races is true also of wild species. Biology has suffered from the circumstance that species have been studied almost exclusively from dead specimens. Attention is focussed on proportions in the dimensions of bones, on number of spines, on antennal joints, on shell markings and so on, and we seem to have overlooked entirely the fact that all these characters constitute only one face of the shield. The structural descriptions of the systematist give us a no more adequate idea of the characteristics of species than does the sight of this exposition on a Sunday when all wheels are stopped and only the form, beautiful and grand as it is, remains give us an adequate idea of it. And so in the study of species we can not understand the form characteristics without considering also the function characteristics. I may illustrate this by some studies which Miss Smallwood has been making at Cold Spring Harbor. She started with a species of Amphipoda—*Talorchestia longicornis*—that lives on the beach where it is rarely covered by the tide. After studying its form and behavior for several months she investigated a second species of the same family of Orchestidæ, *Orchestia palustris*, that lives on the salt marsh to the limit of the highest tides. After studying this for some weeks with respect to behavior correlated with structure she has begun on still a third species of the same family, *Alorchestes*, which is a typical aquatic organism. The instructive thing that comes out of her studies is that in just the same way as these species differ in structural characteristics they differ in functional characteristics and the two kinds of differences go hand in hand and they have to be studied together to be fully intelligible

In still another way are the dynamical and static characteristics bound together, for every form or part has not merely a form or function, but a development, and development is a dynamical process. A decade or two ago embryological development was regarded as a purely morphological subject, as a series of stages, and little attention was paid to the causes that produce the stages and the succession of organs. During the last decade, however, partly under the stimulus of physiologists who have entered the field of embryology, its dynamical problems have been studied also by morphologists. As a result of the researches of Loeb, Driesch, Herbst, E. B. Wilson, Morgan and many others we have come to recognize that the egg is organized —cytoplasm as well as nucleus—and that it exhibits varying degrees of organization in different cases. Sometimes it seems as though every part of the egg was totipotent, as in the medusæ; in other cases, the different parts of the cytoplasm seem told off to develop into particular and definite organs, as in some molluscs. We have learned, further, that at every stage new organs are called forth and their development directed by stimuli proceeding from already existing organs.

Moreover, it has been found that even adult structures are dependent upon external conditions for their form. It appears that peculiar functioning may alter the form of internal organs, as has been demonstrated in the case of a ship's trimmer and of a cobbler by Lane, and as a vast number of pathological cases testify, such as the alteration of the arrangement of plates in the spongy tissue in the head of the femur, and the functional hypertrophy of the other kidney after the loss of one. Morphologists have been forced to realize that form and structure can not be dealt with aside from function and behavior. Every part of the living body is a sensitive responding part whose sensitiveness determines structure. This is seen particularly well when the body is mutilated or a part removed; then begins the wonderful process of regeneration or regulation by which, under control (in the higher animals) of the nervous system, the lost parts are in many cases restored. In truth, the work of the morphologist has extended into the realm of the form-developing and form-maintaining factors and this is a physiological realm.

From these experiences I conclude that the morphologist who studies form characteristics only is too narrow. *Characteristics* in their twofold aspect of form and function should be the object of his investigations—their difference in allied species, their integrity, their behavior in breeding, their phylogenetic origin, their embryological development and their maintenance in the adult.

Morphology has relations with sciences quite outside of biology. I have already insisted that the problems of form and structure are also physiological problems, but in last analysis they are, I think, problems of physics and chemistry. For myself, I have no doubt that we shall some day be able to prove that each characteristic of an organism depends upon a specific substance in the germ cell, and we may hope by altering this substance experimentally to change the corresponding characteristic. Such a change is mutation and mutation in last analysis, as de Vries maintains, depends upon external conditions.

Apart from this it is certain that the physiological processes involved in the individual's characteristics are modifiable and, indeed, controlled by physical agents in the environment. Thus it has been possible to show that certain salts play special rôles in the development of particular organs or characteristics (Herbst). Loeb, indeed, has shown that regeneration of

hydroids does not occur in the absence of potassium. We know, likewise, that iron is necessary to the formation of the chromatin of the nucleus.

The physical conditions have likewise an influence in morphogenesis. The rate of development is controlled within limits by temperature. The number and position of stomata and of leaves by light and moisture; the number and form of plant hairs by moisture; the position of branches and leaves on a stem by gravity; the formation of a hydranth in a hydroid stock by light. So evident is this dependence of morphogenesis upon physical agents that two individuals of the same family develop alike only under the same conditions of environment.

There remain to be considered the relations of morphology to the queen of the sciences—to mathematics. Until recent years little relation has been recognized, and this I attribute to the fact that few naturalists have a type of mind that attracts them to mathematics. They have usually been led to their science through a love of nature—a passion that belongs rather to the poetic type of mind than to the severely precise mathematical. And so I find that, even to-day when the bearing of mathematics on morphological problems can not be overlooked, few morphologists take an interest in the subject of biometry by which the two sciences are connected.

The fact that few morphologists have little taste for mathematics can not stay the inevitable trend of the science toward greater precision of expression and toward mathematical analysis. Until recent years characteristics have been described only in the crude language of adjectives and adverbs—where greater precision is necessary quantitative expression is inevitable. So we have seen during the past ten years the rise of biometry and its application to many morphological problems. Biometry had its beginning in the suggestive investigation of Galton; its great development in the last ten years has been due, above all, to the tremendous activity of Karl Pearson and the workers he has gathered about him. By the aid of efficient methods of analysis we are able to state quantitatively not only the mean value of any measurable characteristic, but also the degree of its variability and the closeness of associated variability of two interdependent organs. Moreover, it is possible to study the nature of the variability exhibited by any characteristic in any homogeneous lot of individuals and to draw an inference from the nature of this variability—as exhibited in the variation polygon—concerning the condition of the characteristic in question in the given race. A person of experience can tell from a glance at the variation polygon whether the race is in a condition of equilibrium so far as this characteristic goes, or whether it is breaking up into several forms or is, perhaps, evolving into some other condition. The quantitative expression gives a means of measuring change of the mode from epoch to epoch which Weldon used in studying the crabs at Plymouth and which enabled him to demonstrate a progressive change in form. It gives also a means of measuring the alteration of an organ in different environments and so of estimating the effects of changed external conditions. Thus it has been shown that the modal number of ray flowers in the ox-eye daisy depends upon the conditions of nutrition in the soil; the chela of the male crab, *Eupagurus,* is relatively smaller in *deep* water; the mud snails, *Nassa,* of *brackish* water are depauperate.

Again, mathematical methods have given us a measure of the correlation between organs, so that the exact relation between human stature and the length of a long bone being known, the stature of extinct

races may be calculated from a collection of disinterred femurs. Pearson has been able to show that there is no correlation between shape or size of the head and intelligence, and to demonstrate the efficiency of vaccination and the non-inheritableness of cancer. The opinion that various bodily characteristics are bound together has been substantiated by studies in the correlation of all sorts of organs in plants and animals and the degree of this correlation measured. This index of correlation measures the degree of morphological kinship or of physiological interdependence. Symmetry gains a quantitative expression and it is interesting to find that originally non-symmetrical organs which have secondarily gained antimeric relations—as in animals that habitually lie on one side—gain a very high index of correlation. Thus I find in the scallops (*Pecten*) which are lamellibranchs that have come to lie on the right side the index of correlation between the dorso-ventral and antero-posterior diameters is 97 per cent., whereas the correlation between the breadths of the right and left valves is only 86 per cent. As heredity is only one phase of correlation, the inheritance of characteristics can, by the new methods, be exactly measured. It is demonstrated that there is such a thing as prepotency of one parent and that heredity is weakened by change of sex. It is shown that mental and physiological characteristics are inherited exactly like morphological characteristics; and that the relationship between the leaves of a branch or the zooids of a colony is like that between brothers of a family. We learn that all inheritance is not all of one kind. That certain characteristics, like stature and skin color, blend in the offspring; while others, like the coat color in mice, refuse to blend and may be inherited according to Mendel's law.

By mathematical analysis the selection of particular characteristics, or those of a particular degree of development, has been demonstrated and the exact effect of the selection process upon the frequency polygon has been made clear. Extreme variants are often annihilated, although in other cases the position of the mode is shifted. Finally, through quantitative studies the existence of local races has been clearly proved—the degree of their differentiation and its dependence on environmental conditions has been measured. It has been shown that a characteristic does not remain the same in all localities and under all conditions, but may become slightly altered. This fact speaks strongly for the contention that new species may in some cases have arisen by the summation of infinitesimal differences—that not all evolution is by mutation.

In concluding this address I am impressed by the fact that to-day any science ramifies in all directions toward every other. There can be no doubt that the most fruitful work in any science is to be done in the border line between it and some other science. There is another corollary to this close interweaving of the sciences and that is that the existing classifications have become antiquated. Our university departments, our societies and our journals still, for the most part, draw the old lines. Yet the true work of science has, I apprehend, overleaped the barriers of these classifications, and the best workers will in the immediate future be no longer botanists or zoologists, or chemists or mathematicians, but will be interested in particular subjects—in following some favorable lead into the unknown. The embryologist who is interested in processes, the cytologist who is interested in the fertilization of the egg will feel free to work on any material, whether plants or animals or crystals or colloidal mixtures—and by any methods that seem likely to be of aid

to him. And I hope to live to see the day when our now overgrown zoological and botanical societies shall languish while groups of men devoted to a common subject and investigating it with the most diverse material will meet together to discuss results of common interest. When a subject no longer demands vigorous investigation and the center of activity is shifted elsewhere I should like to see the old associations abandoned and new ones formed to advance the newly risen problems. Our large societies are a hindrance, I sometimes think, rather than a means of advancement to science. We want smaller meetings with more acute interest. And, finally, I can not but remark on the vastness of the preliminary training which the present ramifications of every science make necessary. Research in the fields between the old sciences has rewards for the investigator, but he who would reap those rewards must prepare himself through years devoted to gaining the mastery of many sciences.

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*THE PROBLEMS OF INTERNAL MEDICINE.**

To recognize, to prevent, to protect, to heal—these are, in the broadest sense, the tasks of internal medicine now as ever. But how different are the problems which occupy our attention to-day from those of the period commemorated by this congress. Let us for a moment glance back at the medicine of the close of the eighteenth and the beginning of the nineteenth centuries. For over two hundred years the blind and binding faith of the middle ages, the faith that had so long fettered the human mind, had been slowly giving way before the forces of reason and truth. Now and again with ever-increasing frequency, great and courageous minds had risen above the clouds of medical tradition and dogma, which had smothered the understanding and reason of mankind, as if, indeed, medicine were a part of the religious doctrine which ruled the world. For truly the medicine of the middle ages was largely a matter of faith, and as a matter of faith one in which reason beyond a certain point was heresy and sacrilege. Vesalius with genius and courage had begun to withdraw the veil from naked and iconoclastic truth. Harvey had made his great discovery. Glisson had demonstrated his theory of irritability. Mayow with his 'Spiritus nitro-æreus' had anticipated the discovery of oxygen. Leeuwenhoek and Malpighi and Hooke had opened to the human eye the realm of the infinitely small. Bacon and Descartes and Newton and Locke had introduced into the world a rational and natural philosophy. Locke, himself, indeed, a wise physician, had pointed clearly to the true path of medical progress. "Were it my business," says he, "to understand physick, would not the safer way be to consult nature herself in the history of diseases and their cures, than espouse the principles of the dogmatists, methodists or chymists."

But the clouds of medical tradition were slow to clear away. Gradually, however, the first 'lonely mountain peaks of mind' had been followed by an ever-increasing number of earnest and untrammeled students. In the seventeenth century the opportunity to give one's life freely to the search for truth had become more and more open to all. The mysticism and animism of Stahl which, in the early part of the eighteenth, hung over the medical world, was already breaking away. The study of the natural sciences was pursued more eagerly and generally than ever before.

* Address delivered before the Section for Internal Medicine of the International Congress of Arts and Sciences, at St. Louis, September 22, 1904.

Reaumur and Black and Haller and Spallanzani and Hunter and Priestley and Lavoisier had lived. Morgagni, sweeping aside the dogmatism of the old schools, had demonstrated the local changes in many diseases and had opened the way for the objective pathological anatomy of Bichat. In the field of practical medicine such men as Sydenham and Morton and Torti and Lancisi practised and taught much which holds good to-day. Boerhaave had introduced clinical instruction. Cullen and Cheyne and Huxham and Pringle and Heberden and Van Swieten and De Haen were all in many ways true and faithful students; yet methods and doctrines that were often strangely fantastic still held general sway—such, for instance, as the Brunonian system. A perusal of the writings of Stoll, one of the wisest practitioners of his day, can not fail to impress one with the meagreness of the basis of anatomy and physiology, normal and pathological, on which medicine rested, the almost entire lack of diagnostic methods, the absence of a rational therapy—how much of the conjectural, how little of the scientifically exact there was in medicine.

Diagnosis, based largely upon gross clinical conceptions, was necessarily vague and uncertain.

Prophylaxis, in the absence of any certain knowledge of the causes and manner of origin of disease, was devoid of any sound basis.

Treatment was almost wholly empirical, and, where it was not empirical, it was frequently based upon some theoretical system so arbitrary and dogmatic that the unfortunate sufferer was too often stimulated or purged, fed or bled, as he fell into the hands of a Brown or a Broussais rather than according to the nature of his malady.

In the Dictionaire de l'Académie française for 1789, a year which marks the end of an era in the world at large, one finds the following definition: "Médecine. s. f. L'art qui enseigne les moyens de conserver la santé & de guérir les maladies (La médecine est un Art conjectural * * *)." Medicine, a conjectural art! Such was the estimate placed upon our profession by the French Academy a little over one hundred years ago.

But the seeds of a new life had been sown and the germination had already begun. Even as these words were written Lavoisier, too soon to fall a victim to the premature explosion of the forces of pent-up freedom, was in the midst of his great work. In 1796 came the introduction of vaccination by Jenner, and but a few years later Bichat, with his wonderful genius, took up the thread dropped by Morgagni and placed anatomy and physiology, normal and pathological, on a basis of accurate observation and experiment. Hand in hand with the introduction of exact methods of anatomical and physiological observation, Auenbrugger in 1761 had demonstrated in his 'Inventum Novum' a method of physical investigation which, for the first time, enabled the physician to determine changes in size, shape and consistency of the thoracic organs. At first unnoticed by the world, this important discovery was destined to gain a sudden general recognition in the early days of the nineteenth century. With the spread of knowledge of the gross pathological changes in disease which followed the inspiration of Bichat, the work of Auenbrugger, expounded by Corvisart, became a common possession of the medical world, and less than ten years later, Laënnec, by the introduction of mediate auscultation, opened possibilities for accurate physical diagnosis such as had not been dreamed of in the ages which had gone before.

With the great school of French observers which followed Laënnec, Andral, Chomel, Louis, Bouillaud and Trousseau,

with Skoda and Schönlein in Germany and Addison and Bright and Stokes in England, the exact association of clinical pictures with local anatomical changes made great advances. Typhus and typhoid fevers were distinguished; the relation between albuminuria and renal disease was demonstrated; the association of endocarditis with acute rheumatism was discovered; the corner-stone of our knowledge of cerebral localization was laid. Clinical diagnosis was becoming more than a conjectural art.

In the meantime physiology was making great strides. Majendie, Bell, Johannes Müller, Beaumont and finally Claude Bernard, and a host of their followers, were shedding light upon many obscure corners of our knowledge of the vital functions. In the hands of Müller the microscope began to open up new fields of study which were destined in a few years, through the cultivation of the genius of a Virchow and a Max Schultze, to bear a noble harvest. The 'great reform in medicine' which followed the introduction of the cellular pathology laid solid foundations for much which is most vital in our anatomical and physiological and pathological knowledge of to-day, and the correlation of these observations with the results of accurately recorded clinical studies, the application of the microscope to the study of the urine, the sputa, the blood, to pathological neoplasms, to exudates and transudates, soon brought new material for the rising edifice of a rational, exact diagnosis. The sphygmograph, the thermometer, the ophthalmoscope, the laryngoscope, the binaural stethoscope, the stomach tube, the various means for studying the blood pressure, all have brought their aid, while but yesterday the discovery of Roentgen has given us new and unhoped for diagnostic assistance.

At the same time, physiological chemistry which, with the work of Berzelius on the urine, had taken its place by the side of the more purely physical methods of investigation, has year by year given us greater diagnostic assistance in the analysis of the different secretions and excretions of the body and in the explanation of the various metabolic processes of the economy.

The development in the hands of Duchenne and Erb and Remak of electrical diagnosis, together with the great advances in physiology and pathology of the nervous system, have afforded explanation for much that was previously incomprehensible and have given us powers of diagnosis which, a few generations ago, would have seemed almost magical.

Finally Pasteur and Koch, with the introduction of bacteriological investigation, opened the way to the discovery of the causal agents of a large group of infectious diseases. These discoveries, followed rapidly by the evolution of methods allowing of the clinical demonstration of many pathogenic micro-organisms, afforded an early, exact and positive diagnosis, on the one hand, in conditions where previously the disease was recognizable only at a stage in which it had made inroads into the system so great as to be often beyond relief, as in tuberculosis, and, on the other, in maladies the existence of which, without these methods, was to be definitely determined only after the onset of an epidemic, as in cholera, plague and influenza. When one thinks of what the last quarter of a century has taught us with regard to tuberculosis, anthrax, tetanus, diphtheria, typhoid fever, cholera, plague, dysentery, influenza, not to speak of the great group of wound infections, we may begin to realize what bacteriological methods have done for diagnosis —how many diseases have been cleared up —how many symptoms have been explained.

In like manner Laveran with the discovery of the parasite of malarial fever,

did much to bring certainty and precision into a field in which many had gone astray, while opening the way for the important observations of Theobald Smith and all the knowledge which we have gained in recent years with regard to the hæmatozoa of man and animals.

As a direct result of the introduction of bacteriological methods, the study of the manner of action of infectious agents and their toxic products upon the animal organism, as well as of the powers of resistance of the economy against infection, has given us, with the discovery of specific agglutinines and precipitines, diagnostic methods of the greatest value, not only for the recognition of various infectious processes, but for the identification of specific sera, affording in particular a test for human blood destined, probably, to prove, when properly applied and interpreted, of great medico-legal value.

This is, indeed, a gain over our knowledge of one hundred years ago. In how many fields has the conjectural given way to the exact! At the end of the eighteenth century the diagnostic effort of the physician, unaided by instruments of precision or even by the simplest physical methods of auscultation and percussion, was directed toward the detection of gross anatomical changes. To-day with our increased knowledge of anatomical, physiological and pathological processes, with our growing insight into the chemical and physical features of vital activity, our duty no longer ends in the recognition of physical changes in organs, in the determination of the presence of a specific lesion or infection; it is, further, our task to search for the earliest evidence of disturbance of function which may later lead to grosser, more evident change, to separate the physiological from the pathological, to estimate, as far as may be, the power of resistance of the different organs and tissues and fluids of the body to insults of varying nature, to determine the functional capacity of a given organ—its sufficiency or insufficiency. In addition to increasing opportunities in the field of pathological anatomy we find ourselves drawn further into the study of pathological physiology—and knowledge in the field of pathological physiology leads of necessity to power in functional diagnosis.

It must be acknowledged that with regard to many organs the determination of the limits of functional power and the estimation of the degree of impairment in disease, are matters most difficult to appreciate, yet with improved methods and persistent research progress is being made.

We are, after all, but beginning to realize a few of the possibilities before us, but even this is a step in advance which holds out no little promise for the future and offers new and tempting opportunities for study and investigation.

At the end of the eighteenth century but three important, rationally conceived measures of prophylaxis had been practised—the dietetic measures of protection from scurvy, the older inoculation and Jenner's great contribution of vaccination against small-pox. It was not, indeed, until the development of bacteriology that prophylaxis took its place as a scientifically exact branch of medicine. The recognition of the specific cause of many infectious diseases, the knowledge of the life history of the pathogenic micro-organisms, the discovery of the portals through which they gain entrance to the animal economy, and the conditions under which infection occurs, have brought to us material powers to prevent and protect. The first great result of this new knowledge was the development of antiseptic surgery and all that it represents. But apart from this we have but to remember what has been gained by a scientifically evolved prophylaxis against

tuberculosis and typhoid fever—to reflect upon how far cholera and plague have lost their terrors—to contemplate the brilliant results of the discovery by Ross and the Italian school of the life history of the malarial parasites as manifested in the anti-malarial campaigns carried on in various regions by Koch, and in Italy by the Society for the Study of Malaria, a noble institution of which our Latin brothers may well be proud, and lastly, to look upon the beneficent and far-reaching influence of the recent work of Reed and Lazear and Carroll and Agramonte with regard to yellow fever, to realize what bacteriological and parasitological studies are doing for preventive medicine.

But beyond this external prophylaxis, the studies of the problems of immunity beginning with Pasteur's inoculations against anthrax in 1881, have given us, so to speak, an internal prophylaxis, a functional prophylaxis if one will, in the possibility of producing a greater or less degree of individual immunity, such, for instance, as is now possible in diphtheria, cholera, plague, typhoid fever and dysentery.

The enforcement of scientifically planned and accurately deduced prophylactic measures has become to-day one of the main duties of the practitioner of medicine. It is as much the task of the physician nowadays to guard over the disposal of the sputa of his tuberculosis patient, of the excreta of the sufferer from typhoid fever or cholera or dysentery, as it is to attend to the immediate wants of the invalid. How rapidly has the exact replaced the conjectural in this branch of medicine!

But while diagnosis and prophylaxis were being removed from the domain of conjecture to the field of exact observation and reason and research, while the possibilities of surgery were rapidly widening through the discovery of anæsthesia and the introduction of antiseptic methods, medical treatment, until the last two decades, still remained largely empirical. The development of exact clinical methods of observation and the statistical tabulation of experience for which we are especially indebted to Laënnec and Louis and their followers, gradually brought about, to be sure, many advances, while a large number of useful therapeutic agents introduced by the newly developed science of pharmacology, and exactly tested by improved methods of physiological study added greatly to the armamentarium of the physician for the relief of symptoms. The power to combat disease specifically, however, remained much as it was at the beginning of the century. Mercury in syphilis, quinine in malarial fever, were the only specifics known to the medical world—and the action of these was unexplained.

The introduction by George Murray, less than fifteen years ago, of the treatment of myxœdema and allied conditions by extracts of the thyroid gland, was a direct application of the results of physiological observation to the treatment of disease. If this gave rise to hopes of the possibility of obtaining like results from roughly obtained extracts of other ductless glands, which have hardly been fulfilled, yet this discovery was the first step toward the rational scientific therapy to which we are beginning to look forward to-day.

But a moment ago I spoke of the importance of the influence of the discovery of the causal agents of the infectious diseases upon the development of exact diagnostic and prophylactic methods. Great and impressive as these have been, yet the studies which have followed as to the manner in which these agents act upon the human organism, and of the powers of resistance which the body exerts against them, the investigation of the problems of immunity, have opened out a far wider field. The early studies of Metschnikoff and Buchner

and Nuttall were followed with rapidity by the epoch-making work of Behring and Kitasato and Roux with regard to tetanus and diphtheria. The diphtheria and tetanus antitoxines were not chance discoveries of empirically determined virtue, but true specific, therapeutic agents, the results of experiment scientifically planned and carefully prosecuted. Widespread investigations of the various phases of immunity, bacterial and cytotoxic, have given us in a few short years a mass of physiological knowledge, the full import of which is scarcely yet to be comprehended. Few things in modern medicine are more impressive than a survey of the work of the last twelve years done under the inspiration of Ehrlich.

Beside the antitoxines of diphtheria and tetanus and the power of producing a greater or less degree of immunity, as has already been mentioned, by preventive inoculations against cholera, plague and typhoid fever, we have come to possess a bactericidal serum of a certain value in combating the actual disease, plague, while the favorable influence of Shiga's antidysenteric serum seems to be undoubted. There is much reason to hope that the recently promised anti-crotalus serum of Noguchi as well as the anti-cobra serum of Calmette may prove to be real boons to humanity. But it is not alone in the production of specific anti-sera, that the therapeutic value of the modern studies of immunity lies. There are signs which justify us in looking forward to the possible discovery of an explanation of the mode of action of substances long empirically used, knowledge the value of which may be readily appreciated.

When we consider these facts it is, indeed, easy to appreciate to what an extent the exact has driven the conjectural from this last field of medicine. A hundred years ago we were depleting and purging and sweating and bleeding according to theories often strangely lacking in foundation, the prevalence of which depended rather upon the individual force and vigor of the expounder than upon their intrinsic merit. To-day from the study of the pathological physiology of bacterial and cytotoxic intoxications, we are rapidly evolving scientific preventive and curative measures, while searching out the rationale and mode of action of our older therapeutic agents.

But a few days ago, I happened to open a copy of Littré* bearing, by a curious chance, the date of 1889, and read "Médecine. (mé-de-si-n') 1° Art qui a pour but la conservation de la santé et la guérison des maladies, et qui repose sur la science des maladies ou pathologie"—an essential modification of the definition of one hundred years before and indicative of the changes of a century.

To meet the manifold problems of to-day the training of the physician must, of necessity, be very different from what it was a hundred years ago. The strong reaction which set in in the earlier part of the nineteenth century against philosophical generalization in medicine, the insistence upon a strict objectivity, all the more emphatic because of the prevalence of anatomical methods of research, have held very general sway. Medicine, no longer resting upon a basis of philosophical speculation, stands upon the firmer foundation of the exact natural sciences. Almost from the beginning the student of to-day is taught methods, where a hundred years ago he was taught theories. The enormous expansion of the field which must be covered has led, naturally, not only to an ever-increasing specialism, but to the fact that the course of study which is regarded as properly fitting the physician for practise is reaching backward farther and farther into the earlier years of his school training.

* Dictionaire de la langue Française.

On the other hand, in this country at all events, there is heard a common cry that the academic medical training is extending on the other side into years which should be given to practise; that the expense and duration of a medical education so-called will soon be such as to shut out from the profession many a man who might be a useful physician and perhaps a valuable contributor to the world's knowledge. To remedy this it is advised that the prospective student of medicine should be led from the earliest stages of his training through the paths of exact research into the domain of the natural sciences to the greater or less exclusion of the classics—the old-time humanities, the study of which, useful as it may be from a standpoint of general mental training, is believed by many to be time wasted in the education of the student destined for a scientific career.

But there are not wanting voices which question the wisdom of the full extent of some modern tendencies. May the affectation of too strict an objectivity bred though it may be of a wholesome skepticism, the more general cultivation of the natural sciences to the exclusion of the humanities, the search for facts and facts alone, circumscribe the powers of synthetical reasoning without which the true meaning of many an important problem might pass unnoticed? May they, perhaps, tend to smother the development of minds capable of grasping large general problems? Do the tendencies of the times justify the epigrammatic observation of a recent French author: "Autrefois on généralisait avec peu de faits et beaucoup d'idées; maintenant on généralise avec beaucoup de faits et peu d'idées"?*

That the cultivation of a strict objectivity in research has materially impaired our powers of reason—that the exact methods which are largely responsible for the enormous advances of the last fifty years in all branches of medicine have bred a paucity of ideas, I am not inclined to believe, despite the seductive formula of our Gallic colleague. But that when, in the period of so-called secondary education, it is proposed to *substitute* the study of the natural sciences for a good training in the humanities, there is danger of drying up some of the sources from which this very scientific expansion has sprung, seems to me by no means impossible. The study of the classics, an acquaintance with the thoughts and the philosophies of past ages, gives to the student a certain breadth of conception, a stability of mind which is difficult to obtain in another way. A familiarity with Greek and Latin literature is an accomplishment which means much to the man who would devote himself to any branch of art or science or history. One may search long among the truly great names in medicine for one whose training has been devoid of this vital link between the far-reaching radicles of the past and what we are pleased to regard as the flowering branches of to-day. Greek and Latin are far from dead languages to the continental student. They are dead to us because they are taught us as dead. With methods of teaching in our secondary schools equal to those prevailing in England and the continent, 'twould be an easy matter, in a materially shorter period, to give our boys an infinitely broader education than they now receive. There should be much less complaint of time wasted, much less ground for suggesting the abandonment of the study of branches which are invaluable to any scholarly-minded man.

The assertion that the time spent in the study of the humanities results, in the end, in the encroachment of the academic training upon a period which should properly

* Eymin, 'Médecins et philosophes,' 8°, Lyon, 1903–4, No. IV.

be given to one's life work is, it seems to me, often based on an old idea—founded all too firmly, alas, on methods that yet prevail in many of our medical schools—that with his degree in medicine the student has finished a theoretical education, that he must now spend five or ten years in acquiring experience—at the expense, incidentally, of the public—before he can enter into his active life; that, therefore, unless some other branches of early instruction be sacrificed to courses leading more directly to medicine so that he may enter upon his strictly professional education at a period considerably earlier than is now the case, the physician of to-morrow will become self-supporting only at a period so late in life as to render a medical career impossible to other than those well supplied with the world's goods. With proper methods of instruction this is a wholly false idea. Under fitting regulation of our system of medical training, with due utilization of the advantages offered by hospitals for clinical observation, the experience necessary to render a man a safe and competent practitioner should be not only offered, but required for a license to practise; and even if the length of the strictly medical curriculum be extended one or two years beyond that which is at present customary, it will not be time lost. If one but look around him he will find, I fancy, that few men who have had such a training wait long before finding opportunities for the utilization of their accomplishments; the public, in most instances, soon recognizes the man of true experience.

But there is yet another side of the question which has hardly been sufficiently emphasized, a side of the question which must come strongly to one's mind when he considers the general education of many of the men who are entering even our better schools of medicine, a point of view which has been especially insisted upon by a recent French observer. A large part of the success and usefulness of the practitioner of medicine depends upon the influence which he exerts upon his patients—upon the confidence which he infuses—upon his power to explain, to persuade, to inspire. It can scarcely be denied that these powers are more easily wielded by the man of general culture and education than by one of uncouth manner and untrained speech however brilliant may be his accomplishments in the field of exact science. I can do no better than quote the words of Professor Lemoine: "C'est qu'en effet l'action morale qu'il peut exercer sur le malade, et qu'il exerce d'autant plus qu'il est supérieur par son intellectualité, est un des principaux éléments de guérison. On guérit par des paroles au moins autant que par des remèdes, mais encore faut-il savoir dire ces paroles et présenter une autorité morale suffisante pour qu'elles entraînent la conviction du malade et remplissent le rôle suggestif qu'on attend d'elles. Ne fut-ce que pour cette raison, je me rangerai parmi ceux qui demandent le maintien d'études claissiques très fortes comme préparation à celles de la médecine, car le meilleur moyen de rehausser le prestige du médecin c'est encore de l'élever le plus possible au dessus de ses contemporains."*

* Indeed the moral influence which he [the physician] is capable of exercising upon the patient and which he exercises to an ever increasing degree with his intellectual superiority, is one of the most important of therapeutic agents. One heals by words at least as much as by drugs, but one must know how to *say* these words and to exercise a sufficient moral authority, that they may bring conviction to the patient and carry the full weight of suggestion which is intended. Were it but for this reason I shall range myself among those who demand the maintenance of extensive classical studies as a preparation for those of medicine for the best means to uphold the prestige of the physician is still to raise him as far as possible above his contemporaries. Congrès Fran-

These words express, it seems to me, a large measure of truth. May it not be that in the tendency to the neglect of the humanities we are taking a false step? May it not be that if, on the other hand, we teach them earlier and better, we shall find in the end that no essential time is lost, while we shall gain for medicine men not only with minds abler to grasp the larger and broader problems, but with materially fuller powers for carrying on the humbler but no less important duties of the practitioner of medicine?

In that which I have just said I have touched upon the necessity of the requirement of a considerable amount of clinical experience as an essential for the license to practise medicine. To meet the enormously increased demands of the present day, medical education has become, of necessity, much more comprehensive, and must therefore extend over a longer period of time. The methods of research, anatomical, physical, chemical, which the student must master, the instruments of precision with which he must familiarize himself, are almost alarmingly multifarious; and experience in the application of these methods and in the use of these instruments demands increased time. Many of these proceedings, it is true, the physician will rarely be called upon to use personally in practise, for such measures must in great part be carried out by special students or in laboratories provided by the government. Nevertheless, with their significance and value he must be familiar—familiar from personal observation and experience.

But after all there are few diagnostic signs in medicine and not so many of the improved methods of clinical investigation yield diagnostic results, while to familiarize one's self with methods and instruments of precision is a very different matter from acquiring real experience and skill as a diagnostician or a therapeutist. It is only by gathering together and carefully weighing all possible information that one is enabled to gain a proper appreciation of the situation and approach a comprehension of many conditions of grave import to the patient. And in forming a sound judgment with regard to these vital questions, that which comes from experience in the close personal observation of the sick is far the most important element. Bedside experience constitutes to-day, as it always has, and always will, the main, essential feature in the training of the physician. But this experience if it is to bear its full fruit, must be afforded to the student at a time when his mind is still open and receptive and free from preconceived ideas —under conditions such that he may be directed by older trained minds into proper paths of observation and study, for few things may be more fallacious than experience to the prejudiced and the unenlightened.

That such experience may be freely offered to the student, there is a grave necessity for a more general appreciation, by institutions of medical training as well as by the powers in control of public and private hospitals and infirmaries, of the mutual advantages to be gained by a cordial cooperation. It must be acknowledged that, in this country at least, despite the cultivation of improved methods of clinical investigation, there still prevails in the mind of the public the perverted idea that this bedside observation, this application of new methods of research and study, are for the advantage of the student or in the interest of general science rather than for the benefit of the sufferer himself. It must further be recognized that a wholly mistaken conception of the true function of a hospital is widely prevalent. It is all too common to see large and ornate institutions

cais de médecine. VI. Session. Paris, 1902, 8°, T. II., p. xli.

with every arrangement for the comfort and even luxury of the patient, with a medical staff utterly insufficient in number or training to properly study the individual case, not to speak of carrying on scientific investigations—the service, usually under the direction of a busy, driven practitioner with barely time to make a short daily visit —large wards under the direct control of one or two young men whose time is wholly occupied by routine work—every care taken for the present comfort of the patient—little provision for enlightened study or treatment of his malady—no opportunities for a contribution on the part of the institution to the scientific progress of the day. Better far for the sufferer were he in the dingy ward of an old European hospital where he might be surrounded by active inquiring minds recording the slightest changes in his symptoms, ever ready to detect and, as far as the power in them lies, to correct the earliest evidences of perversion of function. What our hospitals need is men, students, whether or no they have arrived at the stage in their career—which, after all, is but a landmark, not a turning point—that entitles them to the right of independent practise, the enthusiastic, devoted student who, in watching and studying the patient, is contributing alike to the interests of the sufferer, the hospital and himself.

The three main functions of a hospital, the care of the sick, the education of the physician, the advancement of science, are not to be met alone by the building of laboratories and operating rooms and lecture halls, by the furnishing of the refinements of luxury to the patient, useful adjuvants though these may be. What the hospital mainly needs is men, men to study and think and work—*students of medicine.*

It can not be denied that in this respect we in America are behind our cousins of the old world. Despite our many honorable achievements, the part which we are taking in the modern study of the physiology of disease is still not what it should be.

Ere long we must come to realize that our duty to the sick man consists in something more than to afford him that which most sick animals find for themselves—a comfortable corner in which he may rest and hide from the world; that our duty to the public is to give them as physicians, men of the widest possible general training, ready to enter upon independent practise with an experience sufficient to render them safe public advisers; that our duty to ourselves is to miss no opportunity for the study of pathological physiology at the bedside of the patient; that the accomplishment of these ends depends in great part upon the appreciation by our universities and hospitals of the mutual advantages of cooperation in affording every opportunity for the scientific study of disease while offering to the patient the privileges of enlightened observation and care.

But there are everywhere signs of a future rich in achievement. An improving system of medical education, the increasing opportunities for scientific research offered as well by the generosity of private citizens as by the wisdom of state and national governments, the community of effort which results from closer fellowship among students of all nations, are omens of great promise. The remarkable developments of the last twenty years in all branches of the natural sciences have brought a rich store of suggestion and resource for application in our laboratory, which is at the bedside of the patient. Let us look to it that our clinical methods keep pace with those which are yielding so abundant a harvest in these neighboring fields of scientific research.

WILLIAM SYDNEY THAYER.

BALTIMORE.

THE TRAINING OF THE MINING ENGINEER.*

We are interested in the management of thirty-two mines, of gold, silver, copper, lead and tin. These mines are situated in Australia, New Zealand and elsewhere. In addition, we act for several exploration and development companies, which are engaged in other portions of the world. The thirty-two mines mentioned employ about 9,000 white men, and produce minerals of a gross value of 6,000,000 pounds sterling annually.

In the organization of these enterprises, each single mine is a unit of administration. The head of each unit is 'the manager,' who is not only necessarily a mining engineer, but he is also the commercial head of the enterprise, and, therefore, the dual capacity of technical and commercial execution is combined in one hand. This form of administration of mines causes mining engineering to differ in the requirements of training and experience from most other forms of enterprise where technical skill is required. Under the 'manager,' who has general charge of the mine, is a staff in charge of various departments. These men comprise a mechanical engineer, surveyor, electrician, metallurgist, chemist, foreman, accountants, etc., and, as in the case of the manager of the mine himself, these men are, except the accountants, of technical and semi-technical character, and have, as in his case, executive control of their departments, combining thus again the commercial and the technical administration into one hand. The number of 'superior' men employed varies with the size of the mine, from two technical subordinates, up to as many as fifteen or twenty on large mines. As said above, all of the staff except the accountant are necessarily men of more or less technical training. This technical training has been derived in foundation either from technical schools, or by self-education within the actual field of practise.

In addition to this organization of each unit, these mines are combined into administrative groups under a still superior organization, over which preside engineers of greater distinction and capacity. These men are themselves assisted by a staff of specialists in various departments, and who preside in a general way over all of the mines of their group and their particular departments, in reinforcement of the actual organization of each mine.

As the men thus employed in capacities superior to workmen are paid salaries varying with the importance of their position and their personal qualifications and experience, an easy method of discussion of the results of technical training can be arrived at by dividing them into classes according to their salaries. There are a total of 272 employees of this technical and semi-technical character (omitting accountants and purely commercial agents) in our employ.

The following table shows the number of men, arranged upon this basis, the character and origin of their training:

Class.	Trained in Technical Schools.				Trained in Practise.	Total.
	America.	Australia.	England.	Total.		
Salaries over £4,000.....	5	nil	nil	5		5
Salaries £1,200 to £4,000.....	9	1	2	12	5	17
Salaries £800 to £1,200.....	4	8	1	13	6	19
Salaries £480 to £800.....	3	19	3	25	37	62
Salaries £240 to £480.....	1	18	2	21	148	169
Total.....	22	46	8	76	196	272

In connection with the above, it may be observed that among men of the lower

* This essay is an extract from a private letter. It is published by permission of the author.

ranks, technical education is not so essential for the requirements to the position of assayer, cyanide man, mill man mechanical engineer, foreman, etc., are more of a skilled artisan than that of an engineer. A large portion of the men who fill these ranks are of this type, and have secured their training practically by way of apprenticeship through the actual work. These ranks, however, form the stepping stones from which all men must rise to the leading positions. It would be desirable if, except for some cases as foreman, all of this rank and file were men of the highest technical attainments, as, obviously, the men qualified to occupy superior positions are more advantageous in an inferior position than the man who has at that point reached his limitations.

From our experience and as indicated by practise shown in the table above, there can be no question as to our belief in the value of technical education. Given men of equal qualifications, the man of technical training is bound to rise to the higher position, because of his greater value to his employer.

A side issue in connection with the value of technical training lies in the fact that we have found, as a rule, men who have been technically trained are men by virtue of their education who are endowed with a professional feeling which does not to the same extent exist among those men who have risen from the rank and file. They are, therefore, more trustworthy and, especially in mining work, where such premium for dishonesty exists, for this qualification alone, they are bound to have precedence. We do not by any means wish to disparage the qualifications of many men who have risen from the ranks to eminent positions, but our opinion may be concentrated in the statement that even these men would be better men had they received a thorough technical training.

As to the character of the training which we should desire for men whom we would employ, we can make the following observations:

1. These men should receive a thoroughly broad groundwork of education in the humanities, as well as the sciences, prior to their entrance to technical schools.

2. Their technical training should extend over a period of at least four years, as we believe that any period less than this is quite insufficient in which to embrace the purely theoretical groundwork of the engineering profession which we should desire in our employees.

3. The character of this training should be altogether theoretical, subject to the intercalation of experience set out in paragraph 5. Four years is too short a time in which to embrace any 'practical' training within the working days of a technical institution. Mining engineering requires a broader training than any other engineering branch, as it must embrace mechanical, electrical and civil engineering, as well as applied chemistry and mineralogy.

4. The theoretical training during this period should cover a thorough training in pure science of mathematics, chemistry, physics, geology and mineralogy and mechanics, with special instruction in the applied branches of these sciences, as bearing upon this special branch of engineering. It is our belief that especial stress should be laid upon the purely scientific portion of this training, as under the varied conditions of each new problem this portion is of more use than any knowledge of special application.

5. During the course of theoretical training, in which there must obviously, in any educational institution, be certain vacations, as is done in American universities, in the actual employment of going concerns. Such employment should not be undertaken with a view to the actual ex-

perience gained, as fitting men for final employment on the expiration of the four years, but with a view to rooting in the minds of the men the use and application of the theoretical training which they are undergoing.

6. In the instruction of the applied features of these sciences, we do not believe in any attempt to reproduce actual working conditions, but that all laboratory work should be of a purely theoretical and investigatory character. As this is a disputed point, we may set out our reasons fully. They are:

(*a*) The time of young men in technical institutions can be more usefully employed in theoretical training than practical demonstration, and lack of such theoretical training can seldom be made up in after life.

(*b*) In mining engineering, as we have set out above, the qualifications necessary for our requirements are not only technical, but are also commercial. Men must take on administrative functions. It is impossible to reproduce commercial conditions in any training institution. It has been our universal experience with young men who have come from technical colleges where an attempt was made to give so-called practical instruction, that these men came to us in the thorough belief that they were fully fitted to occupy important positions. The conditions under which so-called practical instruction can be given in technical institutions, reduces them to purely play-house value and gives to the mind of the individual an exaggerated idea of his attainments.

7. Given the student having had four years of theoretical training, which has been founded on a preliminary entrance requirement of broad character, and a certain amount of vacation time spent in works, then this student should, for a period of at least two years, go into active employment of the nature of an apprenticeship. With this period, it should not be the ambition of the student to place himself in a fixed position, but rather to work through the various departments of such section of the industry as he intends to devote himself to, and to undergo this work as an actual workman. An opportunity of this character we are offering to students from the school of mines.

Upon receiving the men from technical institutions, we require them to spend two years or to have had two years' experience in the actual operation of the various departments of mining. In other words, to serve an actual apprenticeship as actual workmen in the various departments, as it is only by this that the youth can get an adequate balance of what constitutes commercial *vs.* theoretical conditions. In questioning the technically trained men employed in the most important positions on our staff, we find that in every single instance these men have served such an apprenticeship, yet we regret to say that in throwing our mines open to young men fresh from technical institutions, that not one out of ten have been content to go through this period of apprenticeship. A great majority has drifted entirely out of the profession. A few have secured positions beyond their capacities and come to worse grief.

In general, we may sum up the position that for our business what we desire are young men of good natural qualifications, thoroughly trained theoretically, without any so-called practical knowledge, unless this knowledge has been gained by employment in actual works, for, as expressed by one of the leading members of our staff, we have not the time nor the inclination to knock out of the heads of these men misimpressions which they have gained by so-called practical training in the technical school.

There are other matters in connection with this question which appear to be of more importance than the pure questions of technical training, and which are deeply rooted in English custom and feeling.

In the first instance, engineers have from time immemorial in this country (England) been educated by an apprenticeship to other engineers. The result has been more or less hand-to-thumb methods. This, of course, can be improved by direct technical training of the character given in America to engineers.

English industries, however, are conducted under two bureaus of administration—commercial and technical. The attitude of the commercial direction always tends towards the greatest immediate result, which usually takes the form of the least outlay of capital. The tendency of the engineer is to get the minimum production cost per unit, which involves large outlays of capital. Neither side is entirely right, and in America this has been successfully overcome by educating the commercial bureau as engineers. In other words, our engineers are administrators instead of consulting men, so that any improvement in English industries must come by a reorganization of their method of administration, as much as by superior education of their men, and this is a matter which can not be accomplished by technical education, and, in any event, would be of very slow growth. There are many hundreds of American engineers in the employ of English concerns, and almost universally they are in executive positions. The whole of the gold mining industry practically is under the direction of American engineers, and England owns mines yielding fully seventy-five per cent. of the gold output of the world, and the American form of administration has been introduced into this industry almost universally.

Another matter which enters into the great English question is that social dignity does not attach to the position of engineer. In the English social mind, the engineer is still an artisan or a tradesman, and the distinction of the engineer as a professional man of equal rank and personal attainments to any other profession has but few advocates in this country. The consequence is that the young men of better families, looking about for a profession, must choose either the law, the church, the army, the navy, medicine or the civil service if they hope to attain social dignity. The result is that it would be very difficult to draw the average brains of the country into the technical branches, whereas I think the feeling in America is quite to the contrary.

HERBERT C. HOOVER.

LONDON.

SCIENTIFIC BOOKS.

RECHERCHES SUR LES SUBSTANCES RADIOACTIVES.

OF the half dozen books which have recently appeared on radioactivity, two are of commanding importance, for they contain the records of the epoch-making work of the two investigators to whom we are most largely indebted for our present knowledge of the phenomena in question, E. Rutherford and Mme. Curie. Of these two wholly dissimilar treatments the former is the more comprehensive and perhaps the more suggestive; for, from beginning to end, it is a presentation of a well-developed theory of the cause and nature of radioactivity. Facts are everywhere grouped about, and fitted into, and interpreted in the light of this theory. On the other hand, Mme. Curie's 'Researches sur les Substances Radioactives,' now appearing in its second revised and corrected edition, deals very sparingly and very conservatively with theory. It is primarily a record of the experimental researches which have been made by herself and her husband during the past five years. Nevertheless, the work of other experimenters is given ample attention, so that the book constitutes a very complete and concise résumé of the present

state of our experimental knowledge of the subject.

The first chapter is a description of Mme. Curie's now well-known researches upon uranium and thorium compounds—researches which led (1) to the discovery of radium, polonium and actinium; and (2) to the announcement that radioactivity, whatever its nature, was an atomic property. This last announcement was based at first upon perhaps rather meager evidence, but it has since met with fuller and fuller confirmation. Nevertheless it still needs more complete investigation.

In the second chapter is found a description (which Madame Curie is of all persons most competent to give), of the methods which have been used in the separation from pitchblende of radium, polonium and actinium. The chapter concludes with an account of what is perhaps the most important work which has come from the hands of Madame Curie, viz., the determination of the atomic weight of radium. Any one who is familiar with the details of this work will be little inclined to credit the correctness of determinations which lead to values other than 225.

The third chapter deals with the nature of the radiations from radioactive substances—a subject in which Rutherford's experiments first brought order out of confusion, but to which the contributions of the Curies have been of but little less importance. The proof that the Beta rays impart negative charges to conductors upon which they fall, and the inverse proof that the body from which these rays emerge is left with a positive charge, were first made by Mme. Curie. Again, the study of the penetrating power of the Alpha rays of polonium, in which the important discovery was made that the fraction of the rays absorbed by various media increases with the thickness of the medium already traversed, was made first by the Curies. It is very difficult at present to reconcile this discovery with Becquerel's conclusion that the magnetic deviability of the Alpha rays diminishes with an increasing distance from the source. The third chapter contains also the important work in which M. Curie demonstrated the ionizing action of radium rays upon liquid dielectrics, and showed that this action is wholly independent of temperature. The chapter concludes with a description of the heating and luminous effects produced by radioactive substances—subjects in which the greater part of the knowledge which we now possess has come from the Curies.

The last chapter, upon induced radioactivity, is perhaps the least satisfactory of any in the book to the student who is not already thoroughly familiar with Rutherford's work on radioactive change, and on the nature of excited radioactivity; for he will be likely to find himself confused by a mass of disconnected facts. Madame Curie is evidently not yet completely converted to the disintegration theory of radioactive processes. She therefore adopts the conservative method of confining herself in the main to a presentation of the existing state of our experimental knowledge, leaving to the last three pages of the book the discussion of the various hypotheses which have been advanced to account for the emission of energy exhibited in radioactivity. Here she presents briefly the four following hypotheses, (1) Atomic disintegration of the radioactive substances; (2) transformation of gravitational energy; (3) absorption of some unknown form of ether energy; (4) atomic disintegration of other substances induced by the presence of a radioactive substance. Although she inclines less markedly than most of us toward the first, a leaning in that direction is nevertheless observable.

R. A. Millikan.

University of Chicago,
October 19, 1904.

International Catalogue of Scientific Literature. First Annual Issue—L—General Biology. London, Harrison & Sons. 1903. Pp. xiv + 144.

This branch of the 'International Catalogue of Scientific Literature' is stated to include the following: "(1) Literature dealing with methods of work and investigation common to all branches of biologic science; (2) Literature dealing with the morphology, development or physiology of living organisms

in general, in so far as the differences between animals and plants do not enter into consideration; (3) Literature dealing with the study of the cell generally."

There are five main headings: 'General'; 'Methods and Apparatus'; 'General Morphology'; 'General Physiology'; 'General Cytology.' That the classification of subject matter is scarcely more than a beginning, is shown by the very small number of subheadings, only 87 numbers out of a possible 9,999 being used. Under 'General Morphology' there occur only four subheadings, namely: 'General'; 'Tectology (Structure of the Individual)'; 'Promorphology (Fundamental Principles of Structure)'; and 'Teratology'; which are numbered 1,000, 1,100, 1,200 and 1,500 respectively, all other numbers from 1,000 up to 2,000 being yet unfilled. 'General Physiology' and 'General Cytology' are somewhat more elaborated, but in the former there are only thirty-two subheadings, and in the latter only thirty-one, out of a possible four thousand in each case. It is easy to point out important omissions which might readily have been avoided. Such a voluminous subject as 'regeneration' is not mentioned. While 'senescence,' 'degeneration' and 'death' are all present, 'growth' is wanting. Physiological articles are found under both 'General Physiology' and 'General Cytology.' Some of the subjects which were pointed out in a previous review (SCIENCE, XIX., No. 493, p. 886) as absent from the branch of the catalogue devoted to physiology proper, are here found under 'General Cytology.' These include 'irritability' and 'fatigue,' but 'summation of stimuli,' 'rhythm,' 'specific energy' and 'automaticity' are omitted, while no mention is made of the tactic irritabilities. If articles on the physiology of the cell are to be indexed in both branches of the catalogue, it would seem to be the most logical and convenient arrangement to employ the same classification for both; but this method is not followed, and with the exception of cross references there seems to be no relation whatever between the two.

The present volume is supposed to include the literature published in 1901, together with a portion of that of 1902. Nine hundred and eighty-two articles are catalogued. The number of American journals is thirteen, of which the *American Naturalist* is credited to the United Kingdom. Cross references to other volumes of the catalogue are very numerous and tend to compensate for the incompleteness of the present volume.

The general impression left by an examination of the volume is that in its present form it is tentative and inadequate. It might easily be made a valuable adjunct to the volumes on botany, zoology, physiology and bacteriology.

FREDERIC S. LEE.
COLUMBIA UNIVERSITY.

SOCIETIES AND ACADEMIES.

THE SCIENCE CLUB OF THE UNIVERSITY OF WISCONSIN.

THE first regular meeting of the club for the year 1904–05 was held October 25, at 7:30 P.M., in the physical lecture room of Science Hall. Dr. V. Lenher gave an account of results obtained in a preliminary study of the gases dissolved in the water of Lake Mendota. It was shown that the amount of oxygen dissolved in the water of this lake decreases rapidly when the thermocline is reached, at a depth of about twelve meters, and that the carbonic acid in the water increases, so that while the surface water is faintly alkaline from dissolved calcium carbonate, the reaction of the water at this depth becomes acid.

The second paper of the evening, by Dr. S. Weidman, treated the subject, 'Wisconsin Iron-Ore Deposits,' with especial reference to the Baraboo district. The first year's shipment (1904) from the newly-discovered Baraboo district in Sauk County will probably reach 100,000 tons. The ore lies in the synclinal valley between the Baraboo quartzite ranges. The ore, associated dolomite, slate and quartzite are of pre-Cambrian age, like the formations in the Lake Superior iron districts. The valley is covered with upper Cambrian sandstone, and explorations are carried on by drilling through this formation. A number of good ore deposits have been

located, and the territory worthy of exploration is quite large. F. W. Woll,
Secretary.

DISCUSSION AND CORRESPONDENCE.

STOMACH STONES.

Those who have been interested in two recent papers concerning pebbles found with the remains of ancient reptiles, may like to read the following: About fifty years ago, some dozen or more hogs were enclosed in a pen which extended into a mill race. The hogs were fed entirely with ground feed in variety —meal, bran, corn and oats or sweepings—but no clover, grass or vegetables, so-called. When slaughtered, there were found in the stomachs of several of the animals, pebbles enough in each to fill the two hands of a man, as well as smaller quantities in some instances. In these cases, this habit was attributed largely to the peculiar diet of the pigs.

W. J. Beal.

To the Editor of Science: A number of instances are claimed of the retention at the present time of habits acquired in former geologic epochs in adaptation to conditions then existent but now changed, rendering the archaic habits to-day useless or even injurious. Such, for example, is the habit of certain migratory birds, in crossing the Mediterranean Sea, of following a line of 'extinct islands'; also the habit of the lemmings of Scandinavia of periodically seeking the 'lost island of Atlantis.'

Is it not *perfectly evident* that in the habit shown by seals and sea-lions of ingesting pebbles we have a retention of an ancient custom dating from the days when seals had gizzards? Maynard M. Metcalf.

THE METRIC SYSTEM.

To the Editor of Science: In the issue of Science of October 21, page 539, is a table of the height of African pygmies. This table is in British measures, and at the close of the article in which the table occurs is this statement: "In the writer's first description of these people in 1897 there occurs a mistake made in the conversion of the metric system to English measure."

Now I am not strictly an anthropologist, but I am interested in some features of the study, and when I take up the more substantial books on the subject, I find the measures given are metric. As physical culture is one of the points that interest me, it would be a great advantage to me if Mr. Verner had published his figures in metric terms. There would then have been no mistakes, and comparisons would have been much easier for those who approach the subject from the cosmopolitan standpoint.

Is it not about time that a paper like Science, which professes to represent the science of this country, should show a preference for the measures employed by almost all scientific workers—to the extent, at least, of printing all quantities in both systems as the medical papers often do? The matter is becoming more and more important every day. See, for example, the embarrassment caused by the two systems of measure in preparing a map of the world, *National Geographic Magazine,* October, page 407.

Wm. H. Seaman.

SPECIAL ARTICLES.

GOVERNMENT SUPERVISION OF HISTORIC AND PREHISTORIC RUINS.

The traffic in prehistoric wares from the southwest that has arisen during the past few years, with the attendant destruction of prehistoric remains, has become a matter of great concern to archeologists, who appreciate the gravity of this loss to anthropological science. Even though much of this material gathered by parties who are only commercially interested in it, eventually finds its way into public museums, its value to science is greatly reduced because of the absence of authentic records. Fortunately, a growing popular and educational interest in historic and prehistoric landmarks has arisen to assist in the preservation of these objects.

As a citizen of New Mexico who has watched with deep concern the loss of many of the incomparable archeological treasures of the southwest, I have recently taken up in a

more serious manner than ever before an inquiry into the question of how these monuments may be permanently preserved and prehistoric relics protected at least long enough to permit of their scientific investigation. During the past few weeks, while pursuing certain lines of research at the national capital, for which the splendid resources of various government departments, bureaus, museums and libraries have been most courteously placed at my disposal, the opportunity has been given me to inform myself fully as to the care which the United States government has exercised over these ruins, is now exercising and stands ready to exercise whenever properly informed. The manifest desire to be informed, and the promptness with which information is digested and acted upon by the departments having jurisdiction over such matters are most encouraging.

In view of the fact that scientific bodies have come to take a commendable interest in this subject, and that various measures looking toward the protection and preservation of our prehistoric ruins have been and now are under consideration and may be brought before the national Congress next winter, it will be helpful in considering such measures to know that a wise and vigorous policy has been developed in the department of the interior with reference thereto. This policy, if vigorously pursued, practically accomplishes the ends to be desired and renders legislation of secondary importance. The following correspondence explains itself. I give, first, excerpts from a letter from the Honorable W. A. Richards, Commisioner of the General Land Office, under date of October 5, 1904.

PROFESSOR EDGAR L. HEWETT,
WASHINGTON, D. C.

Sir: I beg to acknowledge the receipt of your letter of September 3, 1904, transmitting a memorandum relative to the historic and prehistoric ruins in Arizona, New Mexico, Colorado and Utah, and, also, of your letter, under date of September 14, 1904, in relation to proposed legislation for the protection of such ruins.

* * * * * * *

This office fully appreciates the necessity for protecting these ruins and the importance of furthering in every way possible, researches in connection therewith which are undertaken for the benefit of recognized scientific and educational institutions, with a view to increasing the knowledge of such objects and aiding in the general advancement of archeological science; and it desires to aid all such efforts to the full extent of its power, while, at the same time, endeavoring to effectually protect the ruins and relics on the public lands from ruthless spoliation by parties plying a trade in such matters.

* * * * * *

The need for adequate legislation on this subject has, accordingly, been called to the attention of congress by this department for a number of years, but as yet without avail.

In the meantime, every effort has been made to extend such protection to the various regions known to contain objects of interest as is possible without the requested legislation. Certain of the tracts have been protected from appropriation by being temporarily withdrawn from disposal under the public land laws. This action has been taken in the following cases:

In New Mexico: The Pajarito Cliff Dwellers' region, the Jemez Cliff Dwellers' region, the tract known as El Moro, or Inscription Rock.

In Colorado: The Mesa Verde Cliff Dwellers' region.

In Arizona: The tract containing the petrified forest; the greater portion of that part of the district designated by you as the Rio Verde district which lies outside of the Black Mesa Forest Reserve. This withdrawn area contains, among other ruins, the one known as Montezuma Castle.

* * * * * *

As regards the regions which you mention as containing ruins of known importance, which fall within the boundaries of tracts that have been permanently set apart as forest reserves, or just outside of the boundaries thereof, you are advised that they are, in consequence, under the care of the forest force patrolling the reserves, and that instructions have, at different times, been issued to the forest officers in respect to having a general care of these ruins. Further and more specific instructions will now be given in regard to their care, based upon the information furnished by you.

The several regions thus under the supervision of the forest reserve force fall within the districts designated by you as follows:

In the Gila River Forest Reserve, New Mexico: The greater portions of both the Upper Gila District and the San Francisco River District.

In the Black Mesa Forest Reserve, Arizona: A portion of both the San Carlos District and the Rio Verde District; which latter contains what is known as Montezuma Well.

In the San Francisco Mountains Forest Reserve, Arizona: A portion of the Flagstaff District.

* * * * * *

As yet, owing to the lack of sufficient available funds, it has not been practicable to place custodians in charge of the numerous and widely scattered ruins throughout the southwest, except in the case of three localities in Arizona. These cases are: The Casa Grande ruin; the Walnut Cañon ruins, lying partly within the San Francisco Mountains Forest Reserve; the ruins of Cañon del Muerto, within the Navajo Indian Reservation.

It is evident that immediate and effective measures should be taken by the government to protect regions containing objects of such great value to the ethnological history of this country and to other scientific studies; * * *

I am also heartily in accord with your recommendation that, while many of the tracts containing ruins and other objects of interest need only to be temporarily withdrawn and protected until the ruins and objects thereon have been satisfactorily examined and utilized, yet, certain of the most important of these regions should be preserved permanently as national parks, and that a general law be enacted, authorizing the establishment of such parks, and making provision for their proper protection and management.

* * * * * *

(Signed) W. A. Richards,
Commissioner.

The following orders were sent out by the commissioner of the general land office a few days subsequent to the above correspondence:

DEPARTMENT OF THE INTERIOR, GENERAL LAND OFFICE, WASHINGTON, D. C.

October 15, 1904.

Mr. F. S. Breen,
Forest Supervisor,
Flagstaff, Arizona.

Sir: Your special attention is called to the historic and prehistoric ruins located in the San Francisco Mountains and Black Mesa Forest Reserves. As the ruins are almost entirely within said reserves, you are directed to exercise special care in their preservation. For your information in this matter I will state that there appears to be no special statute forbidding scientific research on the public lands, or requiring that permission shall be obtained before undertaking the same or removing objects of value from the public domain. At the same time, however, independent of positive legislative provision in the matter, the United States has all the civil remedies, whether for the prevention or redress of injuries, which individuals possess. And, since all unauthorized excavations upon public lands which tend to the injury of same or of ruins or relics thereon, or the removal of objects of value or of scientific or historic interest, are in the nature of trespass upon the lands, all such intrusion upon public lands renders the parties to the trespasses liable to prosecution.

It is, therefore, deemed advisable that all persons wishing to explore and make excavations of the ruins referred to, should secure permission from the department. This office appreciates the importance of aiding in every way possible all examinations and gatherings of objects of interest upon the public domain, which are undertaken for the benefit of recognized scientific and educational institutions, while, at the same time, endeavoring to effectually protect the ruins and dwellings on the public lands from ruthless spoliation by parties plying a trade in such matters.

You are hereby directed to use your best efforts to carry out the wishes of the department in this matter, and so instruct your subordinates.

Very respectfully,
(Signed) W. A. Richards,
Commissioner.

DEPARTMENT OF THE INTERIOR, GENERAL LAND OFFICE, WASHINGTON, D. C.

October 19, 1904.

Mr. Frank Grygla,
Special Agent, G. L. O.,
Santa Fe, New Mexico.

Sir: Your special attention is called to the subject of the unauthorized explorations and excavations of the historic and prehistoric ruins located upon the public lands for purposes of traffic in the curios, relics and objects of scientific and historic interest taken therefrom.

In order to prevent the further improvident spoliation and destruction of these ruins, and to restrict the explorations and excavations thereof to those made for the benefit of recognized scientific and educational institutions and objects, it is deemed advisable that all persons desiring to engage in such explorations shall secure permission therefor from the department before commencing their operations.

You will take prompt and appropriate measures to insure observance of the department's wishes

with respect to such of said ruins as may be upon public lands, including those temporarily withdrawn with a view to the creation of forest reserves, or for other purposes, in your territory, and you will render all practicable assistance to the forest reserve and Indian officers in their efforts to protect the ruins upon the lands under their supervision from unauthorized explorations and excavations.

If in any instance adequate protection to the public interests in connection with these ruins can not be obtained without recourse to legal proceedings, you will at once report the facts and the means of proving them to this office for consideration with a view to the institution of such proceedings. Very respectfully,

(Signed) W. A. RICHARDS,
Commissioner.

Identical orders were sent to all forest supervisors and special agents of the general land office in the southwest. These orders cover not less than three fourths of all the ruins of New Mexico, Arizona, Colorado and Utah.

On or near all the important ruins that are situated on lands controlled by the General Land Office which have been withdrawn either permanently or temporarily the following notice, printed in conspicuous type on large sheets of tough white cloth, is kept posted by range riders and other officers:

WARNING:
DEPARTMENT OF THE INTERIOR,
GENERAL LAND OFFICE,
WASHINGTON, D. C., May 24, 1904.

Notice is hereby given that these lands have been withdrawn, for public purposes, from settlement, entry, and other disposal.

All persons are prohibited, under the penalty of the law, in such cases provided, from committing thereon any trespass whatever, and from working in any manner whatever any injury, waste, or damage of any kind to these public lands and to the timber, natural curiosities, caves, ruins, objects of antiquity, or any other public property thereon, and from removing or in any way disturbing the same. W. A. RICHARDS,
Commissioner of the General Land Office.
Approved: E. A. HITCHCOCK,
Secretary of the Interior.

The following excerpts from a letter from Hon. A. C. Tonner, acting commissioner of Indian affairs, set forth the policy of that department on the same subject:

DEPARTMENT OF THE INTERIOR, OFFICE OF INDIAN AFFAIRS, WASHINGTON, D. C.
October 22, 1904.

EDGAR L. HEWETT, ESQ.,
WASHINGTON, D. C.

Sir: This office is in receipt of your communication of the 17th instant,

* * * * * *

In reply you are advised that this office has been and is fully alive to the importance of preserving the various ruins and remains of antiquity scattered throughout the southwest, and has heretofore issued stringent orders to many of the Indian officials in charge of the reservations to which you refer—especially to those in charge of the Navajo, Moqui and Hualapi reservations. Quite recently this office, in order to prevent the spoliation of the prehistoric ruins in the cañons of De Chelly and Del Muerto, recommended to the secretary of the interior that a custodian be appointed to have charge of the ruins in the said cañons, and authority was granted by the secretary therefor and the custodian is now on duty.

In view of your present request the officials in charge of the various Indian reservations to which you refer have, in letters of this day, been advised relative to preventing further injury to ruins and suppressing the traffic in prehistoric pottery which may be found on the reservations under their care.

Their attention has been invited to the previous instructions of the office relative to this matter and they have been requested to use their best endeavors to keep out intruders and relic hunters and to see that such of the remains of antiquity as may be located within the reserves under their respective charges are kept intact until such time as proper scientific investigation of the same may be had. Very respectfully,

(Signed) A. C. TONNER,
W.M.W.—L.M. *Acting Commissioner.*

Following is a copy of orders sent out from the office of Indian affairs October 22:

DEPARTMENT OF THE INTERIOR, OFFICE OF INDIAN AFFAIRS, WASHINGTON, D. C.
October 22, 1904.

JAMES B. ALEXANDER, ESQ.,
SUPERINTENDENT PIMA INDIAN SCHOOL,
SACATON, ARIZONA.

Sir:

* * * * * *

It has been and is the policy of this office to prevent all unauthorized persons from entering

Indian reservations and despoiling historic or prehistoric ruins and taking therefrom any relics or remains of antiquity whatever. To this end your predecessors in office or perhaps you have heretofore been advised of the wishes of this office in this respect and requested to take such action as might be necessary to the end that proper protection should be afforded in the premises and all spoliation of these valuable ruins be prevented.

* * * * * *

It is desired that you take this matter up and issue such orders or instructions and take such action as may be necessary to carry out the wishes of this office as heretofore expressed. Should you have Indian police under your charge, they should be properly cautioned and instructed. Further, reliable and trustworthy chiefs and headmen of the tribe might likewise be advised of the desire of this office to protect these remains of antiquity from being despoiled by curio hunters, etc., and directed to aid you so far as possible in the matter.

Should unauthorized persons be found on the reservation or reservations under your charge and engaged in the work of excavating or collecting relics, etc., they should be removed from the reservation and the facts in the case be reported to this office in full.

Very respectfully,

(Signed) A. C. Tonner,

W.M.W.—L.M. *Acting Commissioner.*

In reply to a letter addressed to Mr. W. H. Holmes, chief of the Bureau of American Ethnology, inquiring what steps were being taken by that bureau with a view to putting the Interior Department in possession of information that would be helpful in carrying out the policy of the department relative to the southwestern ruins, I received the following communication:

SMITHSONIAN INSTITUTION,
BUREAU OF AMERICAN ETHNOLOGY,
WASHINGTON, D. C.

November 19, 1904.

My dear Mr. Hewett:

I beg to acknowledge the receipt of your letter of the 16th instant, making inquiries regarding the steps now being taken by the Bureau of American Ethnology in furnishing information to the Interior Department relative to the location, character, and condition of the various historic and prehistoric ruins of the Southwest.

In reply I have to say that much progress has been made in the preparation of maps and descriptive lists of the various archeological sites of the Pueblo region. The Bureau has been conducting explorations among these sites at frequent intervals ever since its foundation, and has published numerous reports and maps embodying the results of its researches. The preparation of a general archeological map has been in hand for several years, and the data amassed is laid down on the Geological Survey maps, upwards of 50 of the topographical sheets covering parts of Utah, Colorado, New Mexico and Arizona having been utilized in this manner.

Accompanying the maps is a card catalogue of the sites, giving more or less complete data relative to the ruins and other remains. Recently a demand for this class of information has arisen in the Interior Department, and in order to properly meet this demand the work has been taken up afresh and reliable information from all sources is being brought together. The data previously collected is now being transferred to the latest editions of the maps on which we are laying down all Indian Reserves, private land grants, and township and section lines. Distinctive symbols are used for the various classes of remains, thus aiding in identification of particular sites; and the catalogue as recently remodeled, embodies a wide range of information, especially such as is likely to be of service to the Interior Department. The work is rapidly covering all the public lands on which archeological remains of importance occur and progress maps will soon be submitted for publication. Copies of these will, if deemed advisable, be placed in the hands of land surveyors, Indian agents, custodians of reservations, teachers, and others employed in the region or having knowledge of its ancient ruins, in order that all possible additions may be made.

It is expected that in a few years the record of our more important antiquities, already completed and published for the Mississippi Valley and the Gulf states, will be extended to cover the entire country.

I am enclosing herewith samples of the catalogue cards recently introduced. They provide spaces for recording data as follows: State, county, township, range, section, drainage; map (name of sheet), number of site, class or kind of remains, common or aboriginal name, where such exist, people, if known; needs of protection, of custodianship and repair; availability for research; history and bibliography.

The information thus gathered will be available for use by the Interior Department at an

early date, although the data with respect to many important sites will necessarily be imperfect.

Very truly yours,

W. H. HOLMES,
Chief.

MR. EDGAR L. HEWETT,
U. S. National Museum.

Identical orders were sent at the same time to superintendents of Indian schools, agents and additional farmers throughout New Mexico, Arizona and Colorado. These orders cover about one fourth of all the southwestern ruins. It will be seen that these various sets of orders from the two departments embrace practically all of the ruins that are not under private ownership.

It definitely mobilizes, so to speak, a force of forest supervisors, rangers, special agents, Indian school superintendents and teachers, Indian agents, farmers and police, and even enlists the Indians themselves, a particularly sagacious step, in the protection of these ruins for the avowed purposes of preserving them for scientific investigation. It establishes the broad and liberal policy that any competent scientist, who desires to place the material secured in a reputable public museum, will be authorized by the department of the interior to examine ruins, but that no person will be permitted to enter and excavate them for the purpose of acquiring specimens for traffic or private gain, and that willful destruction of valuable historic and prehistoric landmarks must cease.

Most archeologists will agree with Governor Richards that this subject calls for some judicious legislation, but they will be especially gratified to know that, pending such enactment, an efficient and economical policy has been developed in the department of the interior which is being made operative as promptly as circumstances will permit. The main thing, a system of governmental protection of archeological remains, is manifestly an accomplished fact, as much so, and after the same manner, as is the protection of timber on public lands. It will be effective just so far as the commissioners of the general land office and of Indian affairs are furnished with means adequate to carry the system into effect. It would now seem that all concerned can best serve the interests of science and of the public by upholding this wise policy. I would further suggest that all workers in the southwestern field should make it their duty to keep the department of the interior informed of violations of the above orders which come to their notice and that they should henceforth refuse to purchase for museums any specimens or collections that are not secured by parties duly authorized to collect the same by the secretary of the interior. A specimen not secured by legitimate authority and not accompanied by authentic record should have no place in a reputable museum.

The bill proposed by Commissioner Richards as a substitute for all the pending bills on the subject is embodied in his annual report for 1904 to the secretary of the interior which can doubtless be had by addressing him. I regard it as a sound measure which provides in a simple and direct way for the end to be accomplished, and which should precede any further special enactments.

EDGAR L. HEWETT.

LAS VEGAS, NEW MEXICO.

NOTES ON THE HISTORY OF SCIENTIFIC NOMENCLATURE.

THEOPHRASTUS REDIVIVUS.

ALL who delight in contemplating the extraordinary attainments of the Hellenic mind, whether expressed in art, literature or science, will rejoice at the appearance of Dr. Hugo Bretzl's learned treatise on 'Botanical Knowledge resulting from the Alexandrian Conquest.'* This work of over 400 pages unquestionably ranks as the most critical and thoroughgoing discussion extant of the earliest botanical contributions that have come down to us from the olden time.

Naturally, the chief sources of material are those furnished by the writings of Theophrastus, disciple of Plato and Aristotle, and successor of the latter. Additional information of great value, especially as regards the extinct mangrove colonies along the Red Sea and Persian Gulf, to say nothing of general natural history, is contained in those oldest

* 'Botanische Forschungen des Alexanderzuges,' Leipzig, 1903.

of nautical journals, the logs of Nearchus and Androsthenes—Alexander's admirals—portions of which have fortunately survived for 2,200 years.* All these ancient documents are remarkable for their absolute fidelity to nature, the accuracy of Theophrastus's descriptions leaving little room for doubt that this keen observer personally accompanied the famous expedition.

Notwithstanding the earlier commentaries of Scaliger, certain difficulties peculiar to Aristotelian writers have rendered Theophrastus largely unintelligible to modern students. These hindrances are partly of formal nature, partly due to the exceedingly colloquial style of description employed, and in still larger measure to the absence of illustrations and of a definite nomenclature. All the more gratifying is it, therefore, to find that most of the obscurities vanish before the penetrating analysis of philology, the original meaning becoming once more revealed like a restored palimpsest. The practical value of these researches consists in their disclosure of a means for identifying many of the species mentioned by Alexandrian botanists, which in turn provides us with important data in regard to plant distribution at a period more than two thousand years distant, together with changes in climatal and geographical conditions. Mention might also be made in this connection of Lenz's 'Botanik der alten Griechen und Römer' (Gotha, 1859), and of his 'Zoologie' (1856). A more popular recent work is Watkins's 'Gleanings from the Natural History of the Ancients (London, 1885).

* Theophrastus availed himself of both of these itineraries in the preparation of his treatise, as did also Strabo, Pliny and later writers. The narrative of Nearchus owes its preservation chiefly to Arrian, historian of the Macedonian invasion. Several English translations of the text are extant, and the points at which the fleet touched have been determined by Tomaschek and others. Copious notes on these and other ancient itineraries are given in M'Crindle's 'Ancient India as described in Classical Literature' (1901).

WHAT IS A BRICK?

A BRICK is a rock. So a geologist has told us. Construction bricks, gold bricks, coal briquettes—possibly even ice cream bricks—all are rocks. Moreover, they belong to particular kinds of rocks. Careful investigations into the nature of 'bricks, plaster, concrete, cement and all other rocks which receive their characteristic features through man's agency' have enabled a writer in the *American Geologist* (33, p. 228, 1904) to dispel all doubt in the matter.

Among the clarifying conclusions reached by this purist we note that burnt bricks, as material, must be considered as æthobalic bioclastics.' Sun-dried bricks, plaster and cement fall harmoniously into the system as 'biolutytes'; concretes are 'biorudytes,' their texture being 'rudaceous'; and impure clay rocks, from which brick material is derived, are 'siliceous or calcareous anemoargillutytes.' As for the pure anemoclastics (*sic*), these are separated into 'anemosilicarenytes' and 'anemocalcarenytes' as easily as falling off a log. The whole scheme is adorably simple, and simply adorable—to all such as prefer new and pedantic terms to common English expressions.

With becoming modesty the author suggests that 'the compound terms here given may be found useful in descriptive writing, especially as they are almost self-explanatory.' That the word *almost* may cover a multitude of sins is apparent from the fact that over a score of pages are consumed in explaining these mellifluous compounds. It is a satisfaction to find ourselves at one with the author in his concluding observation, to the effect that 'stratigraphers will scarcely need terms more precise than those here given.'

LITHOPHAGI.

HOMER and Herodotus have immortalized the Lotophagi, Alexander's historians the Ichthyophagi; and it has been reserved for Dr. S. W. Williston (SCIENCE, No. 513) to leave 'not a shadow of doubt' that plesiosaurs belonged to the Lithophagi. Evidence of collectors seems to be convincing that pebbles were actually swallowed by plesiosaurs in large quantities; but we are inclined to think that even Swift's 'bold man that first eat an oyster'

would have flinched before the 'gizzard' proposition.

Had Dr. Williston stated his syllogism as follows: 'All birds have feathers; the sage hen is a bird; therefore the sage hen has feathers'—he would have substituted the exact converse of our argument with respect to reptiles. Negative evidence is, of course, unconvincing, and there are paleontologists who may say: 'It is conceivable that some reptiles had feathers, though none are now known to possess them; therefore, it is possible that plesiosaurs (and other reptiles) had feathers.' To them we answer, it is also *possible* that plesiosaurs rejoiced in having a vermiform appendix; and the author* who recently described a specimen of *Hybodus* with a school of Belemnites inside, might have gone a step further than he did, postulating appendicitis as cause of death. As it was, we shall hardly contest his verdict in pronouncing it acute indigestion: 'bei der Verdauung traten dann Beschwerden ein.'

INTRODUCTION OF THE TERMS GEOLOGY AND PALEONTOLOGY IN NATURAL SCIENCE.

THE opinions of so eminent an authority as Dr. S. F. Emmons are entitled to universal esteem. When this learned writer tells us in SCIENCE (No. 512) that he 'should have considered it a useless waste of time to have searched all ancient literature to find out by whom it [the term geology] was first used,' most of us will cheerfully agree with him.

When, however, he reiterates the statement that 'de Saussure was the first *geologist* to use this term' in its modern acceptation, only a moment's time is required to satisfy one's self of its historical inaccuracy. In the work of von Zittel to which Dr. Emmons refers (page 106 of the German edition), the credit for having introduced the term geology in a scientific sense is awarded to Deluc (1778). Deluc and de Saussure were contemporary scientists, but the employment of the term geology by the former antedates that of the latter.

If one can spare a moment further, still without 'searching all ancient literature,' one may consult a standard authority like Murray's 'New English Dictionary' (Oxford). Under 'geology' the earlier use of the term by de Bury in 1344, and by F. Sessa in 1687, is referred to, after which it is remarked: 'So far as at present known, the use of the word as a name for a distinct branch of physical science occurs first in English,' references being given to E. Warren (1690), B. Martin (1735) and Bailey (1736). Von Zittel is also authority for the statement that the term paleontology was introduced almost simultaneously by de Blainville and Fischer von Waldheim during the third decade of the nineteenth century.

COSMOGRAPHICAL KNOWLEDGE OF THE ANCIENTS.

THE appearance of a revised edition of Hugo Berger's 'History of Comparative Geography amongst the Greeks' furnishes occasion for a brief notice of this exceedingly valuable repository of information.* Of wider scope, yet more compact than Bunbury's and other standard histories of ancient geography, the plan of the present work aims to provide an epitome of all the essential facts, together with a profusion of references to original sources, and to commentaries upon the same.

Although dealing primarily with descriptive geography in the pre-Christian era, the subject necessarily includes cosmical, geological and physiographic aspects of earth-science in general; and from this it follows that the attempt to trace interrelations between authors belonging to different periods and schools, with the aid of our present materials, is an intricate task. Herein probably lies the explanation of the numerous repetitions and cross-references which occur throughout the work, a feature which is no less conspicuous in Humboldt's 'Cosmos' and similar treatises.

The critical acumen of the author may be best appreciated through comparison of judgments passed by him upon this or that heroic figure in science, compiler, or commentator, with the judgments already passed upon them by equally erudite explorers of the same field. Divergence of opinion is to be noted in many

* Campbell Brown, 'Ueber das genus Hybodus,' etc., Palæontogr., **46**, p. 163 (1900).

* 'Geschichte der wissenschaftlichen Erdkunde der Griechen' (Leipzig, 1903), pp. 662.

cases, sometimes flat contradiction; but it is safe to say that wherever Dr. Berger gives his individual estimate of ancient wayfarers along the road to knowledge, he has formed his opinion from profound and conscientious study.

The subject-matter of the work is arranged chronologically according to authors, and as the latter are generally occupied with a surprising variety of topics, the historical continuity of certain lines of investigation becomes obscured by this method of presentation. A remedy for the defect would have been to summarize in special chapters the progress made in the study of particular phenomena, such as the cosmical relations and movements of the earth, volcanic activity, tides, petrifactions, and the like. Tozer's 'History of Ancient Geography' is arranged partially after this fashion, and is excellently adapted, by the way, as an introduction to the work above considered.

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BOTANICAL NOTES.

THE STUDY OF PLANT DISEASES.

An interesting pamphlet comes from the antipodes under the title of 'Letters on the Diseases of Plants,' by N. A. Cobb, of the Department of Agriculture of New South Wales. In somewhat over a hundred and thirty pages the author has brought together the substance of a great number of letters written in reply to correspondents. He has recast the matter so that the epistolary form has been obliterated, and he has added a large number of cuts in the text, and a dozen full-page plates (some colored). Here in compact form is to be found a great deal of information in regard to many plants, stated in such non-technical English as to render it easily comprehensible by any intelligent person. There is first a long discussion of ripe rot, the fungus of which (*Glœosporium fructigenum*) attacks the fruits of many different plants. The results of many interesting experiments are given in detail. Banana seab (*Phoma* sp.), stigmonose (due to insect punctures), mouldy core of the apple (*Penicellium*, *Mucor* and others), quince rots, peach curl (*Exoascus deformans*), lemon and orange diseases, diseases of the passion vine, potato diseases, root-rots and timber rots, are among the topics more or less fully treated in this valuable publication.

THE STUDY OF WOODS.

Another book on the structure and uses of the woods of commerce has made its appearance in England under the title of 'The Timbers of Commerce, and their Identification.' It is from the hand of Herbert Stone, F.L.S., and is issued by Rider & Son, of London. It constitutes a neat volume of about 350 pages, and is beautifully illustrated with 186 photographs showing the grain of cross and longitudinal sections of wood. There is a general introductory chapter on the structure of wood, and following this are the descriptions of 247 different species. These descriptions are very concise, a short paragraph (or line) being given to each of the following topics: Natural order, synonyms, sources of supply, alternative names, physical characters, grain, bark, uses, etc., authorities, color, pores, rays, rings, soft tissue, pith, radial section and tangential section. There is a good deal of similarity between this book and the one prepared by Professor Snow last year under the title of 'The Principal Species of Wood,' and noticed in these columns (Science, July 3, 1903), at the time of its appearance. The American book takes up only about half as many species as the English book, and its descriptions are shorter, covering fewer points, yet the much better arrangement and the careful selection of species in the former make it by far the more useful for the American student or artisan.

COMPARISON OF EASTERN AND WESTERN FLORAS.

The recent publication of two local floras permits a comparison between an eastern rocky area with one consisting of typical prairie conditions. George G. Kennedy's 'Flora of Willoughby, Vermont,' originally published in *Rhodora* for June, 1904, takes up the plants of Willoughby Mountain, Willoughby Lake and the vicinity, in northern Vermont. The elevation of the lake above the sea is 1,060 feet,

while the summit of the mountain is 2,650 feet. The list includes 570 native and 120 introduced species.

R. S. Cratty's 'Flora of Emmet County, Iowa,' enumerates the plants of a prairie area in northern Iowa. Here the surface is gently rolling, and there are no rock exposures within the county. The general surface has an elevation of about 1,500 feet above the sea, and its latitude is within a couple of degrees of that of the area covered by Mr. Kennedy's list. Mr. Cratty's list includes 532 native and 58 introduced species. Comparing the two we find that there are 42 species of trees in the Willoughby flora, and 31 in Emmet County. The representation of the principal families and larger groups is as follows (introduced species are given after the plus sign (+)):

	Willoughby.	Emmet.
Pteridophytes	63	9
Gymnosperms	9	1
Naiadaceæ	8	13
Vallisneriaceæ	1	2
Gramineæ	40+22	54+9
Cyperaceæ	76	53
Juncaceæ	11	6
Liliaceæ	15+3	15+1
Orchidaceæ	27	5
Salicaceæ	12	11
Betulaceæ	8	2
Fagaceæ	2	2
Ulmaceæ	2	3
Polygonaceæ	4+8	13+2
Chenopodiaceæ	1+1	2+2
Caryophyllaceæ	1+1	3+3
Nymphæaceæ	3+1	2
Ranunculaceæ	14+4	21
Cruciferæ	7+10	10+7
Rosaceæ	19	15
Pomaceæ	6+1	5
Drupaceæ	4	3
Cæsalpiniaceæ	0	1
Papilionaceæ	2+7	23+6
Euphorbiaceæ	0+1	2
Aquifoliaceæ	2	0
Hypericaceæ	5+1	2
Violaceæ	11+1	3
Umbelliferæ	6+3	11+2
Cornaceæ	4	5
Ericaceæ	22	0
Gentianaceæ	2	5
Asclepiadaceæ	1	8
Boraginaceæ	1	4+1
Verbenaceæ	0	3
Labiateæ	10+7	14+2
Solanaceæ	1	3+2
Scrophulariaceæ	3+3	14+1
Rubiaceæ	6	5
Caprifoliaceæ	10+1	6
Campanulaceæ	4+1	4
Compositæ	64+21	70+10

The small representation of Pteridophytes, Gymnosperms, sedges, orchids, violets and Ericaceæ, in Emmet County, and the larger numbers which it has of Naiadaceæ, native Gramineæ, native Polygonaceæ, Papilionaceæ, Verbenaceæ, Solanaceæ, and native Compositæ, are remarkable.

TREES AND SHRUBS IN CANADA.

A RECENT bulletin (47) issued by the Canadian Department of Agriculture contains the results of a large number of trials of trees and shrubs which have been planted at the experimental farms at Brandon and Indian Head, situated respectively in the provinces of Manitoba and Assiniboia. These farms are on the Great Plains of Canada, near latitude 50° north. After sixteen years of testing a large number of species, the following are the more important trees and shrubs which have proved quite hardy: box elder, Tartarian maple, western June-berry, paper birch, Siberian pea-tree, Siberian dog-wood, red-osier dog-wood, hazel-nut, hawthorns (several species), broom, Russian olive, green ash, honeysuckles (several species), balsam poplar, cottonwood, black poplar, aspen, western wild cherry, pin-cherry, Canada plum, Siberian crab-apple, mountain ash, bur-oak, buckthorn (several species), smooth sumach, roses (several species), willows (several species), buffalo berry, spiræas (several species), snowberry, lilacs (several species), white elm, white spruce, black spruce, Engelmann's spruce, blue spruce, jack pine, stone pine, Scotch pine, Riga pine and tamarack. The bulletin must prove most useful for Canadian planters.

CHARLES E. BESSEY.
THE UNIVERSITY OF NEBRASKA.

A NOTE ON WESTERN FARM VALUES.

NORTHERN and eastern Iowa comprise one of the most highly developed agricultural dis-

tricts in the entire west. The features of the system of farming which separate this from other sections are complete crop rotation and maintenance of soil fertility by means of live stock. Dairying and stock raising have a firm place in one of the most completely developed systems of cultivation in the Mississippi valley. In essential respects this section is comparable to the system of farming to be found at its best in eastern Pennsylvania, especially in the Susquehanna valley. Since 1895 prices of land have gone up throughout the central and northwestern states, to a level which no one could possibly have anticipated. Farm lands in Illinois (west central) sell from $100 to $150 per acre, along the route of the C. B. & Q. R. R. The tenant pays a rental of from $5.00 to $7.00 per acre and has made money at that. But he has in all probability not made money enough to induce him to invest it in farm lands there. The value of lands has reached a point at which he can earn more on his capital as a tenant than as an owner of high-priced lands. Consequently tenantry and landlordship are on the growth with the rise of the purchase price of agricultural lands.

One explanation of this rise in land values is the presence of surplus capital in the hands of farmers. A farmer who had his farm nearly or entirely paid for before the rise of farm prices since 1895 has been able, as a rule, to put money in the bank year by year. If he has not put it into securities which the financial centers of the country manufactured for consumption by the money-making public, he naturally may be expected to avail himself of opportunity to buy land as it comes into the market. This form of interest he knows something about, and he puts his savings in it regardless of the low rate of returns he knows he must get. But he knows it is sure. Take a corresponding case in land values in Pennsylvania. Farms are being sold in much of the most improved portion of that state at prices which represent little more than the value of the improvements. Farm land in a high state of cultivation is valued at less than has been the case for some years. Productivity has not declined and prices have improved with the general rise of agricultural prices. Where then does the cause for the difference in values in western and eastern farming lands lie?

JOHN FRANKLIN CROWELL.
WASHINGTON, D. C.

THE NATIONAL ACADEMY OF SCIENCES.

THE autumn meeting of the National Academy of Sciences was held at Columbia University on November 15 and 16. No business of general interest was transacted at the scientific session. The papers presented were as follows:

W. H. DALL: 'Biographical Memoir of Charles Emerson Beecher.' (By title.)

W. K. BROOKS: 'On the Affinities of the Pelagiac Tunicates.' (Illustrated by lantern slides.)

W. K. BROOKS and S. RITTENHOUSE: 'The Life History of *Turritopsis*.' (Illustrated by lantern slides.)

W. K. BROOKS and R. P. COWLES: '*Phoronis architecta*, its anatomy, life history and branching habits.' (By title.)

JOHN TROWBRIDGE: 'On the Electrical Resistance of a Vacuum.' (Illustrated by lantern slides.)

FRANZ BOAS: 'Psychic Association in Primitive Culture.'

M. I. PUPIN: 'Time Electrical Impulses.' (Introduced by R. S. Woodward.)

C. BARUS: 'The occurrence of maxima and minima of atmospheric nucleation in approximate coincidence with the winter and summer solstices respectively.'

C. A. BAUER: 'The System of Magnetic Forces causing the Secular Variation of the Earth's Magnetism.' (Introduced by R. S. Woodward).

RUSSELL H. CHITTENDEN: 'The Influence of Low Proteid Metabolism on the Formation and Excretion of Uric Acid in Man.' (Illustrated by lantern slides.)

EDWARD W. MORLEY: 'Note on the theory of experiments to detect the second power of the aberration of light.'

EDWARD W. MORLEY: 'Report of a repetition of the Michelson-Morley experiment on the drift of the earth through the luminiferous ether.

C. S. PEIRCE: 'On Topical Geometry.'

N. YATSU: 'An Experimental Demonstration of the Formation of Centrosomes *de novo*.' (Presented by E. B. Wilson.)

T. H. MORGAN: 'An Analysis of the phenomena of Organic Polarity.' (Introduced by E. B. Wilson.)

E. B. WILSON: 'Experiments on Prelocalization in the Annelid Ovum.'

C. E. MENDENHALL: 'The absolute value of the Acceleration of Gravity determined by the Ring-Pendulum Method.' (Presented by R. S. Woodward.)

R. S. WOODWARD: 'The Double Suspension Pendulum for measuring the Acceleration of Gravity.'

EDGAR F. SMITH: 'Biographical Memoir of Robert Empie Rogers.' (By title.)

CHARLES F. HASTINGS: 'A Determination of the Dispersive Power of the Human eye.'

CHARLES F. CHANDLER: 'The Air in the New York Subway.'

SCIENTIFIC NOTES AND NEWS.

THE Hotel Walton, Locust and Broad Sts., Philadelphia, has been chosen as the headquarters of the American Association for the Advancement of Science and affiliated societies, for the meeting that opens at the University of Pennsylvania, on Wednesday, December 28.

THE seventeenth winter meeting of the Geological Society of America will be held at Philadelphia, beginning on December 29. The meeting will be called to order by President J. C. Branner, at 10 o'clock.

THE Royal Society has awarded its Rumford medal to Dr. Ernest Rutherford, professor of physics at McGill University, for his researches on radioactivity.

M. PERROT, professor of pharmacology, University of Paris; M. Henri Moissan, professor of chemistry, University of Paris; K. H. F. Rosenbusch, professor of mineralogy and geology, University of Heidelberg; Otto Bütschli, professor of zoology and paleontology, University of Heidelberg; Wilhelm Ostwald, professor of chemistry, University of Leipzig; Wilhelm Pfeffer, professor of botany, University of Leipzig, have been elected corresponding members of the Vienna Academy of Sciences.

THE Rev. Stephen D. Peet, editor of the *Antiquarian,* has been elected a corresponding member of the Anthropological Institute of Great Britain and Ireland.

ON the evening of November 14, a dinner was given in Cambridge to Sir John Murray and Professor Albrecht Penck, of Vienna, a number of professors and students of Harvard University being present.

DR. J. K. SMALL, curator of the Museum of the New York Botanical Garden, is in Florida studying the flora of that region.

UNDER the auspices of the Corporation of Newbury, a public museum was formally opened in that borough, on October 26, by Mr. Jonathan Hutchinson, F.R.S.

SIR JOHN BURDON-SANDERSON, F.R.S., has been made a perpetual delegate of the University Museum, Oxford.

THE following is a list of fellows who have been recommended by the president and council of the Royal Society for election into the council for the year 1905, at the anniversary meeting to be held in November 30: *President,* Sir William Huggins, K.C.B.; *treasurer,* Mr. Alfred Bray Kempe; *secretaries,* Professor Joseph Larmor, Sir Archibald Geikie; *foreign secretary,* Mr. Francis Darwin; *other members of the council,* Dr. Shelford Bidwell, Mr. George Albert Boulenger, Colonel David Bruce, R.A.M.C., Mr. Frank Watson Dyson, Professor Percy Faraday Frankland, Professor Francis Gotch, Dr. Ernest William Hobson, Professor John Newport Langley, Mr. John Edward Marr, Sir William Davidson Niven, K.C.B., Professor William Henry Perkin, Jr., Professor John Perry, Mr. Adam Sedgwick, Dr. William Napier Shaw, Professor William Augustus Tilden, Rear-Admiral Sir William Wharton, K.C.B.

PROFESSOR E. SALKOWSKI, director of the chemical department of the Pathological Laboratory of the Charity Hospital at Berlin, well known for his work in physiological chemistry, celebrated his sixtieth birthday on October 11.

PROFESSOR THEOBALD SMITH, of Harvard University, will deliver an address upon 'The Place of Research in the University Medical School,' before the Harvard Medical Society of New York City, at the New York Academy of

Medicine, on Saturday, November 26, at 8:30 P.M.

On November 17, Dr. H. W. Wiley addressed The New York Academy of Medicine, on 'The Influence of Preservatives in Foods on the Public Health'; on November 18, the College of the City of New York, on 'The Attitude of the Consumers towards Purity of Foods'; on November 22, The National Union, a fraternal insurance organization at Detroit, Mich., on 'Food-Quantity and Quality.'

At the Royal Institution, London, a Christmas course of lectures, adapted to a juvenile audience, will be delivered by Mr. Henry Cunyngham, C.B., on 'Ancient and Modern Methods of Measuring Time' (experimentally illustrated). The dates of the lectures are: December 27, 29 and 31 and January 3, 5 and 7.

The British Academy commemorated the bicentenary of the death of Locke, on October 28. Papers by Professor Campbell Fraser, on 'Locke as a Factor in Modern Thought,' and by Sir Frederick Pollock, on 'Locke's Theory of the State,' were read by the secretary in the absence of the authors.

Dr. Thomas Messinger Drown, president of Lehigh University and previously professor of chemistry at Lafayette College and the Massachusetts Institute of Technology, died on November 16 at the age of sixty-two years.

Mr. Frank McClean, F.R.S., a well-known British engineer and astronomer, died on November 8, at the age of sixty-six years.

The Massachusetts Institute of Technology has been awarded six prizes for its exhibit at the St. Louis Exposition. The awards are as follows: Grand prize for general exhibit, gold medal for mining engineering exhibit, silver medal for special exhibit of drawing, silver medal for special exhibit of photography, students' work, etc., and a bronze medal for a special exhibit of transparencies.

Columbia University has been awarded prizes at the St. Louis Exposition as follows: Grand prizes to Columbia University, for its general exhibit, and to President Butler for twenty educational monographs entitled 'Education in the United States.' Gold medals to the Department of Botany, for its special exhibit; to the Departments of Mining and Metallurgy, for their special exhibits; to Teachers College, for its special exhibit; to Professor J. McKeen Cattell, for his monograph on Scientific Societies and Associations; and to Professor Edward Delavan Perry, for his monograph on The American University. Bronze medals to the Department of Indo-Iranian Languages for its special exhibit.

Hobart College has been awarded a gold medal for its astronomical exhibit at the World's Fair. The distinguishing feature of the astronomical exhibit was a photographic collection of the cometary discoveries, now twenty-four in number, made by Professor Brooks.

The New York *Evening Post* states that the Peabody Museum, of Yale University, has received a collection of Indian relics from Christopher Wren, of Plymouth, Pa. The collection includes Indian pestles, scrapers and other utensils. Professor Schuchert, the new head of the museum, is planning an extensive relabeling and reclassification of the objects in the museum by which, for one thing, the vertebrate fossils will be grouped together, and, as far as possible, arranged topographically.

The Free Museum of Science and Art of the University of Pennsylvania has received a gift of several rare collections of North American Indian relics from Messrs. John Wanamaker and Thomas Donaldson.

The Royal Institution, London, has received a gift of £750 from Ludwig Mond and a bequest of £100 under the will of Miss Harriet J. Moore.

An American Forest Congress, under the auspices of the American Forestry Association, will meet in Washington, January 2 to 6, 1905, under the presidency of James Wilson, secretary of agriculture. The sessions of the congress will be held in the National Rifles Armory. On the afternoon of January 5, President Roosevelt and other prominent men will address a special meeting in the Lafayette Theater. The subjects to be considered at the congress are: (1) Relation of the Public Forest Lands to Irrigation; (2) Relation of

the Public Forest Lands to Grazing; (3) The Lumber Industry and the Forest; (4) Importance of the Public Forest Lands to Mining; (5) Forestry in Relation to Railroad Supplies; (6) National Forest Policy; (7) State Forest Policy.

THE twelfth National Irrigation Congress held its annual session last week at El Paso, Texas, under the presidency of Senator Clark.

AT a meeting of the council of the Michigan Academy of Sciences, held on November 12, the date of the next meeting was set at March 31 to April 1, and the place Ann Arbor.

AT the 23d annual meeting of the Natural Science Association of Staten Island the following were elected officers for the ensuing year: *President,* Howard R. Bayne; *secretary,* Arthur Hollick; *treasurer,* J. Blake Hillyer; *curator and librarian,* C. A. Ingalls.

THE fourth volume of Professor Moritz Cantor's 'Vorlesungen über Geschichte der Mathematik' will contain the history of mathematics for the period of forty years, from 1759 to 1799. The preparation of the volume is divided up among different authors as follows: (1) 'Geschichte der Mathematik, Klassikerausgaben Wörterbücher,' von S. Günther (München); (2) 'Lehrbücher der Elementargeometrie, Praktische Geometrie (Feldmesskunst), Elementargeometrische Einzeluntersuchungen Parallelenlehre,' von V. Bobynin (Moskau); (3) 'Trigonometrie, Polygonometrie, Tabellen (trigonometrische, logarithmische und andere)' von A. v. Braunmühl (München); (4) 'Rechenkunst und Buchstabenrechnung, Algebra (Lehre von den Gleichungen) Zahlentheorie,' von F. Cajori (Colorado Springs); (5) 'Reihen, Kombinatorik, Wahrscheinlichkeitsrechnung Imaginäres,' von E. Netto (Giessen); (6) 'Analytische Geometrie der Ebene und des Raumes,' von V. Kommerell (Reutlingen); 'Darstellende Geometrie,' von G. Loria (Genua); (7) 'Lehrbücher der Infinitesimalrechnung, Einzeluntersuchungen der Infinitesimalrechnung, Bestimmte Integrale Transzendenten,' von G. Vivanti (Messina); (8) 'Totale und partielle Differentialgleichungen, Variationsrechnung Differenzen- und Summenrechnung,' von C. R. Wallner (München); (9) 'Entwickelung der Mathematik zwischen 1759 und 1799, Geschichte der Ideen in diesem Zeitraume,' von M. Cantor (Heidelberg).

THE statutory annual meeting of the Royal Society of Edinburgh was held in the Royal Institute, Edinburgh, on October 31, Lord M'Laren presiding. The following members of the new council were elected: *President,* Lord Kelvin; *vice-presidents,* Professor James Geikie, Lord M'Laren, the Rev. Professor Flint, Dr. Robert Munro, Sir John Murray and Dr. R. H. Traquair; *general secretary,* Professor George Chrystal; *secretaries to ordinary meetings,* Professor Crum Brown and Professor D. J. Cunningham; *treasurer,* Mr. P. R. D. Maclagan; *curator of library and museum,* Dr. Alex. Buchan; *councilors,* Dr. John Horne, Mr. C. G. Knott, Professor R. Stockman, Professor James Walker, Professor Andrew Gray, Mr. Robert Kidston, Dr. D. Noel Paton, Professor John Chiene, Professor J. Graham Kerr, Mr. William Peddie, Dr. Leonard Dobbin and Professor J. C. Ewart.

UNIVERSITY AND EDUCATIONAL NEWS.

THE daily papers state that it is proposed to move the Western University of Pennsylvania from the suburbs of Allegheny to Pittsburg proper, near the new Carnegie Technical School. About fifty acres of ground, sufficient for twenty large university buildings, is being secured at a cost of about $2,000,000, and the work of construction will be begun before long. Fifty citizens of Pittsburg have agreed to give each from $40,000 to $100,000 for the school. The contribution of Mr. Carnegie has not been announced.

THE general assembly of the state of Vermont has appropriated $60,000 for the use of the agricultural department of the university. The money is to be expended in the erection and equipment of a building to be known as Morrill Agricultural Hall, in memory of the father of the agricultural colleges of the country, the late Senator Justin S. Morrill. The building will be devoted to instructional and experimental work in agriculture.

COLUMBIA UNIVERSITY, by a decision of the Court of Appeals, will take possession of real estate bequeathed by Stephen W. Phœnix, of New York, and yielding an annual rental of about $10,000. The bequest was contested by Mr. Phœnix's family.

A STATEMENT has been issued by the rector of the Catholic University announcing that no part of the $100,000 collected for the university last year has been lost through the failure of the treasurer. The amount that the university has lost or is liable to lose is not, however, stated. It seems extraordinary that a university should loan its endowment fund at six per cent. interest to an individual who used the money for real estate speculations.

C. P. CHASE, treasurer of Dartmouth College, announces the gift of $1,000 by the Earl of Dartmouth to the fund for the rebuilding of Dartmouth Hall.

THE preliminary register of the Johns Hopkins University shows the total enrolment to be 740, against 696 at the same period last year. This is the largest enrolment in the history of the institution. The faculty, including assistants and lecturers, numbers 160, a gain of ten over last year. There are 291 candidates for the degree of M.D., compared with 275 last year, the total number of graduate students being 556, an increase of sixteen over the year preceding. Undergraduate students number 186, a gain of 17 per cent. over the enrolment at the same time last year. Candidates for the A.B. degree next June number thirty-three.

THE department of geology, of the University of Chicago, has arranged for the following special courses to be given during the winter and spring quarters of 1905:

January 2–February 10.—(1) Courses in Nonmetallic Economic Geology, by E. R. Buckley, Ph.D., state geologist of Missouri. (*a*) An elementary outline course; (*b*) An advanced course on structural materials.

February 13–March 24.—(2) Courses on Pre-Cambrian Geology, by Professor C. K. Leith, University of Wisconsin. (*a*) The Archeozoic and proteozoic Formations; (*b*) Laboratory course on metamorphic rocks, accompanying the above.

April 3–May 12.—(3) Courses on Ore Deposits, by F. L. Ransome, U. S. Geological Survey. (*a*) An elementary course on ore deposits in general; (*b*) An advanced course on gold, silver, copper and lead (in part) ores.

DR. CHARLES W. DABNEY was installed as president of the University of Cincinnati on November 16. His inaugural address was entitled 'Democracy and the School.'

MR. CLIFTON D. HOWE, assistant in botany in the University of Chicago, has been appointed instructor in botany in the Biltmore Forest School, Biltmore, North Carolina, and will begin his new duties on January 1.

WE learn from the *Electrical World* that Dr. F. A. C. Perrine, chief engineer of the Standard Electric Company, of California, has become a member of the faculty of the Polytechnic Institute of Brooklyn. Dr. Perrine will affiliate with the department of electrical engineering as consulting professor in long distance electric power transmission. Dr. Louis Duncan has been appointed consulting professor of electric traction. Dr. Duncan was the organizer and head of the department of electrical engineering at Johns Hopkins University, and recently reorganizer of the department of electrical engineering at the Massachusetts Institute of Technology.

MR. T. D. A. COCKERELL has been appointed lecturer on entomology in the University of Colorado, Boulder.

PROFESSOR JAMES ROBERTSON, commissioner of agriculture and dairy of the Dominion of Canada, has resigned from the government service and will take charge of the agricultural college to be established near Montreal by Sir William McDonald.

DR. J. F. POMPECKY, for the last ten years associated with the late Professor Karl von Zittel, at Munich, has been appointed professor of geology in the agricultural school of Hohenheim, near Stuttgart.

DR. KARL EXNER, professor of mathematical physics at Innsbrück, and Dr. A. Bauer, professor of chemistry at the Vienna Polytechnic Institute, have retired from active service.